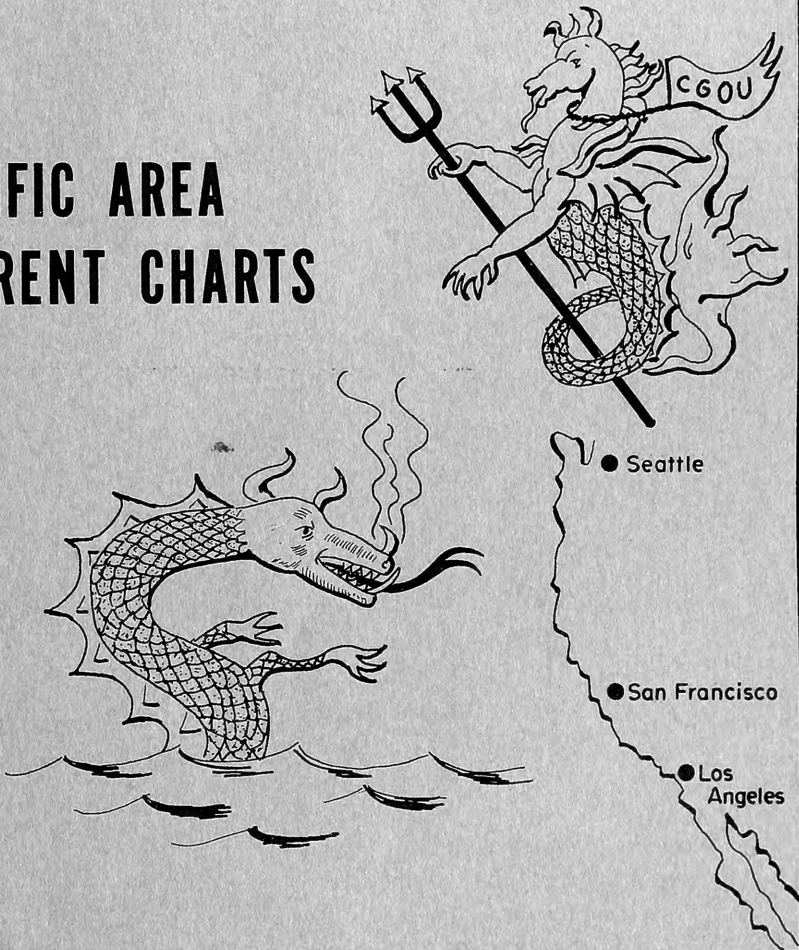
DEPARTMENT OF TRANSPORTATION

COAST GUARD

PACIFIC AREA CURRENT CHARTS



Oceanographic Unit Technical Report 82-2

PACIFIC AREA CURRENT CHARTS

BY

DR. KENNETH A. MOONEY
LCDR ALAN D. SUMMY

U.S. Coast Guard Oceanographic Unit
Operations Division

Navy Yard Annex
Washington, D.C. 20593
Telephone: (202) 426-4634

U.S. COAST GUARD TECHNICAL REPORT

ABSTRACT

A monthly mean sea current was calculated for the west coast of the United States and the Hawaiian Islands area on a spatial grid of 1° by 1°. These mean geostrophic velocities were computer generated from dynamic height data obtained from the National Oceanographic Data Center. A method employing two-dimensional spline fits of spatially and temporally random hydrographic data was developed to determine the monthly averaged geostrophic currents.

TABLE OF CONTENTS

Title Page.. i

Abstract.. iii

Table of Contents.. v

Introduction... 1

Procedure.. 3

Data Presentation.. 5

References... 6

MONTHLY MEAN SEA CURRENTS FOR THE WEST COAST OF THE UNITED STATES AND HAWAII

BY

Dr. Kenneth A. Mooney[1]

LCDR Alan Summy, M.S.[1]

INTRODUCTION

In 1977 the Oceanographic Unit was given the general task of providing improved current information for various areas around the coastal United States and Hawaiian Islands. The problem has been that for drift calculations the standard method used was to vectorially add a sea current, a wind current, and a leeway factor. This method depends on the accuracy of the various components. At the time of this study the sea current being used was one derived mainly from historic ship set and drift measurements. Set and drift measurements do not accurately reflect the sea current both because of the dead reckoning navigation errors and the fact that they also contain an inherent wind current component. Thus when these quasi sea currents are combined with a wind current the result would be to over-drift the object of the search.

The Oceanographic Unit has endeavored to improve search planning by upgrading the mean sea current used. The method used to determine this permanent, large scale flow of the oceans required a detailed knowledge of the mean temperature, salinity, and density fields in an area. Due to the large scope of area to be covered and the prohibitive cost of ship time the Oceanographic Unit turned to the National Oceanographic Data Center where such information is available for many parts of the world's oceans.

The result of the analysis of this historical hydrographic data was the production of mean sea current charts on a maximum grid of 1° by 1°. These mean sea currents are the mean geostrophic currents computed from dynamic

height anomalies and contain no wind-current contamination. To be used in drift forecasting they must be combined vectorially with a wind current calculated for the specific time and area of interest. A method for calculating a local wind current can be found in Oceanographic Unit Technical Report 78-2.

---

[1] U.S. Coast Guard Oceanographic Unit, Building 159-E Navy Yard Annex, Washington, D.C. 20593

PROCEDURES

The Method

Since the data was temporally and spatially random it required the use of special methods to analyze the data. The most direct method would be to group together all the dynamic depth anomaly data for a particular month and then fit this data by the method of least squares with a two-dimensional polynomial. The virtue of this particular method is that it treats each data point as an independent measure of the dynamic depth field. The latitude and longitude are used as the independent variable because this is the most convenient form in which to obtain the data from NODC. The north-south and east-west velocities can now be obtained by solving the following equation:

$$U = \frac{10}{f\,R\,\sin\theta}\,\frac{\partial\, dD}{\partial\phi}$$

$$V = -\frac{10}{fR}\,\frac{\partial\, dD}{\partial\theta} \qquad (1)$$

where

U = north-south velocity

V = east-west velocity

f = Coriolis Parameter

R = Radius of the earth

θ = Latitude

dD = Dynamic depth anomaly

ϕ = Longitude

The dynamic depth anomaly field frequently displays so much structure that to replicate it with a single function would require a polynomial of prohibitively high order. This difficulty was overcome by the use of two-dimensional spline fits of the data. The advantage of spline fitting is that the data which was previously fitted by one polynomial is now fitted by several polynomials, allowing much more structure to be represented. Equation (1) can still be used to evaluate the components of geostrophic velocity.

To put this method into use a spline fit program called SPLAK which employs third-order polynomials was obtained from the National Center for Atmospheric Research (NCAR) Software Support Library. Even with spline fits, the area to be analyzed was too large to be fitted by a single spline fit. Thus it was specified that the program have nine rectangles to analyze with the size of the rectangles being left as a variable that could be changed as dictated by the needs of a particular study area. The reasoning for using nine rectangles was that the best fit to the data would occur in the center rectangle where the outer boundary effects were least significant. The total area of interest would then be analyzed by choosing an appropriate size for the nine rectangles according to the amount of structure present and then moving the center rectangle around the total area of interest with some continuity being supplied from one position of the center rectangle to an adjacent position by means of the overlapping effect of the eight surrounding rectangles. This approach allowed different size areas to be analyzed with equal accuracy and also allowed for the development of a generalized program applicable to any area. Besides the size of the rectangles, the relative depth to which the currents were referenced, i.e. the level of no motion, and the time period over which the currents were averaged were both variables which were specified in the program.

For the results presented in this report the program was run with rectangles equal to 1° of latitude by 1° of longitude. Since most of the hydrographic data extended only to 500 meters that depth was chosen as the reference level enabling the use of most of the available data. While 500 meters may appear to be somewhat shallow for those who normally use 1000 meters or 1200 meters as a reference level, cross-checking when possible showed no significant differences in surface velocities when 500 meters versus 1000 meters was used as a reference level. The spline fit was evaluated at the center of rectanges $\frac{1}{4}°$ by $\frac{1}{4}°$, $\frac{1}{2}°$ by $\frac{1}{2}°$, and 1° by 1° on their sides. In the final analysis the current structure was such that no areas required rectangles smaller than $\frac{1}{2}°$ by $\frac{1}{2}°$ to properly characterize the currents.

Data Presentation

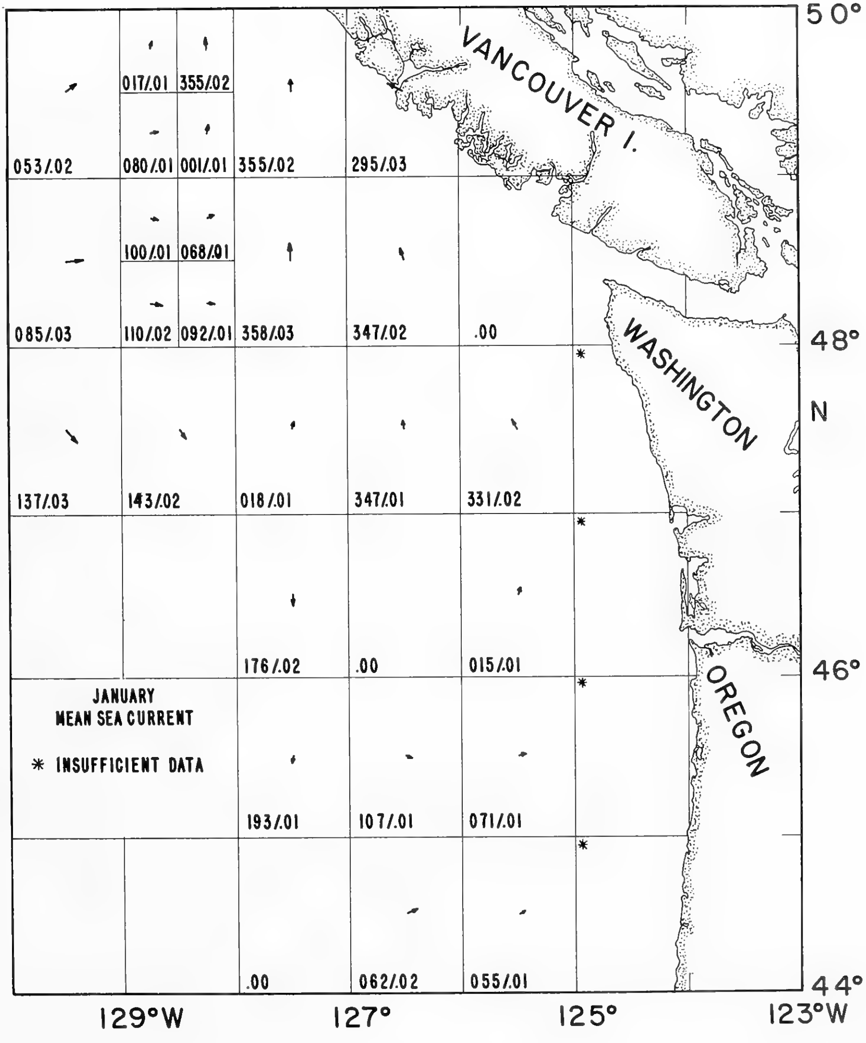
The results of the analysis are depicted for each area in twelve chartlets, one for each month. At the bottom of each block you will note that on the left of the slash is the current direction in degrees true and to the right of the slash is the current speed in knots.

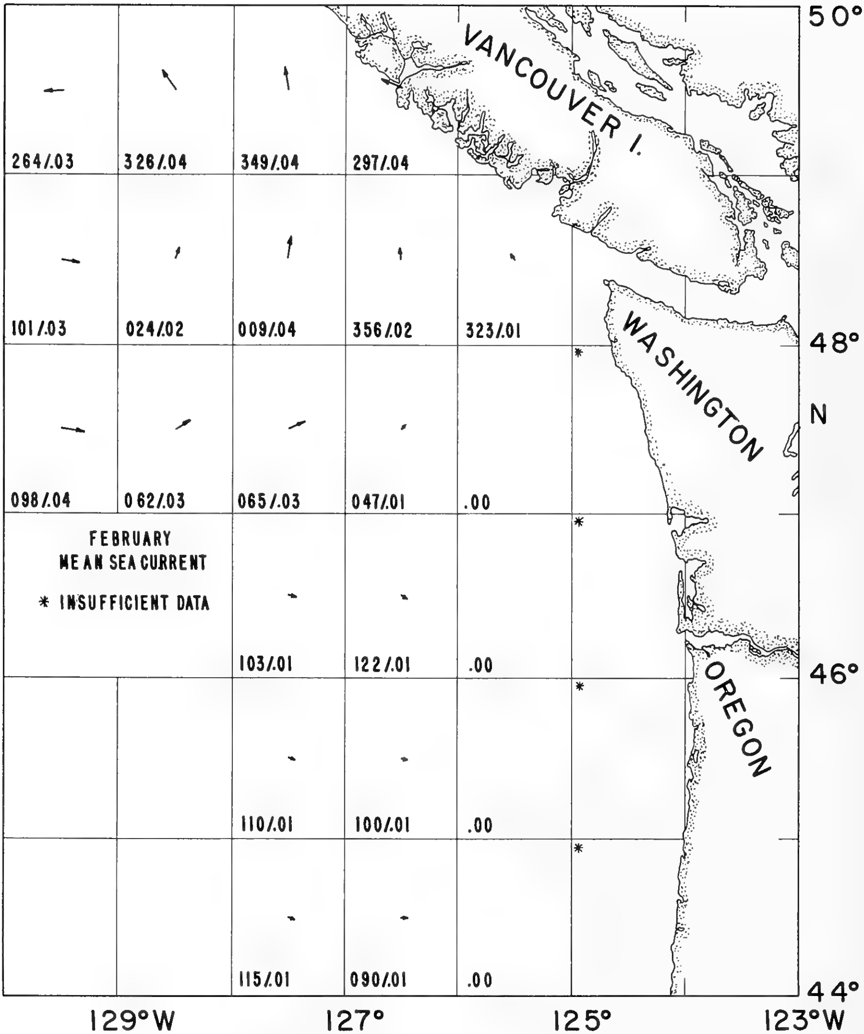
REFERENCE

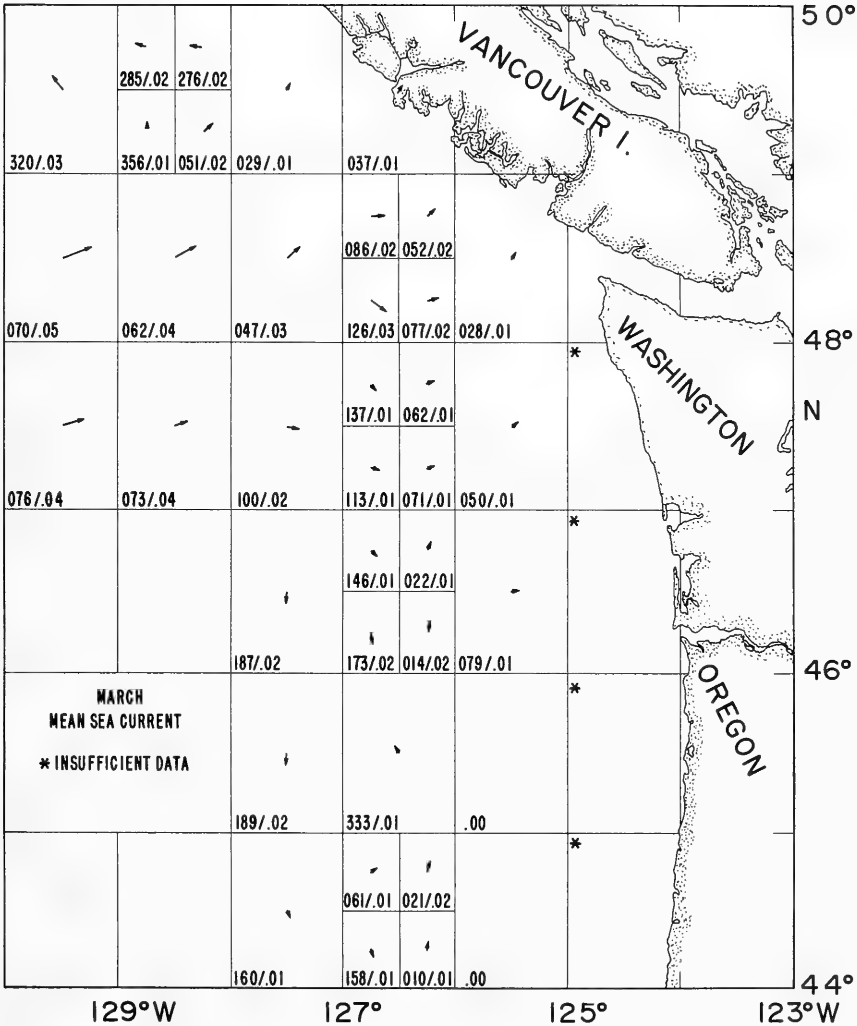
1. Adams, J.C., A. K. Cline, M.A. Drake and R. A. Sweet, eds., NCAR Software Support Library, NCAR-TN/IA-105, 1975.

2. Mooney, K.A. The Determination of Average Geostrophic Current Velocities from Temporally and Spatially Random Hydrographic Data with an Application to the Southern California Bight, U.S. Coast Guard Technical Report.

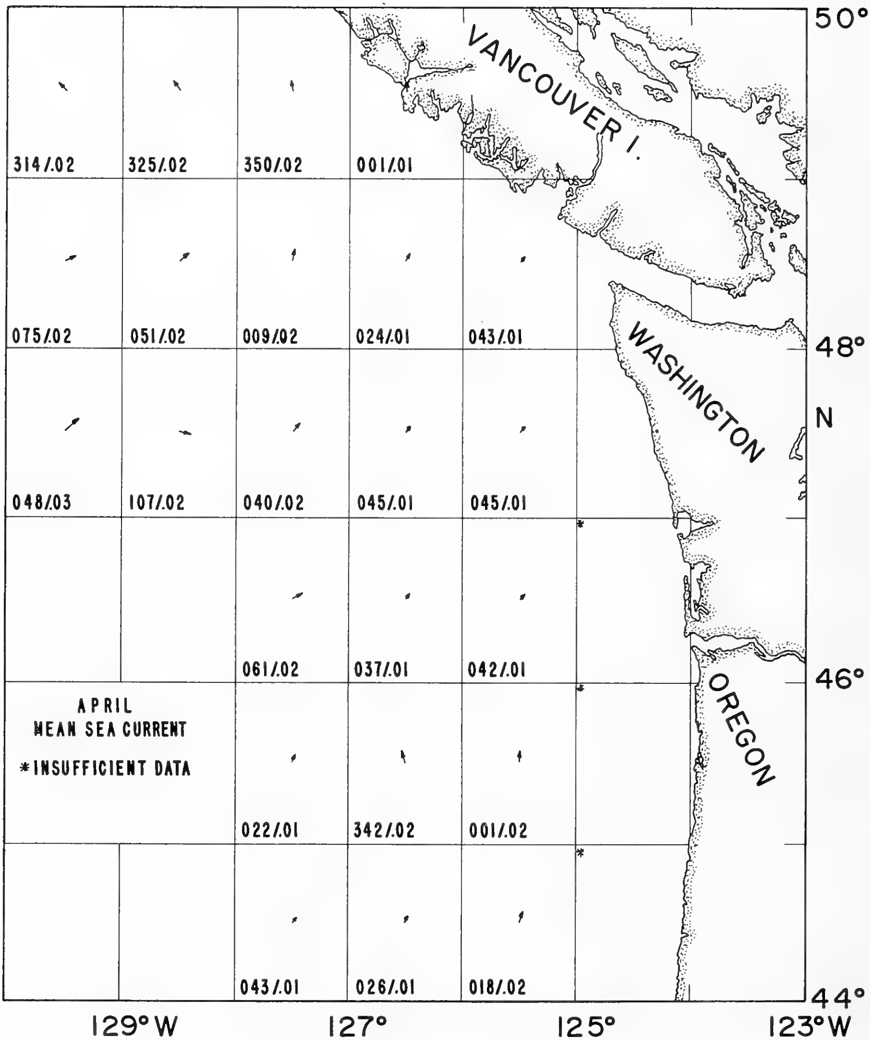
3. Mooney, K.A. A Method for Manually Calculating the Local Wind Current, U.S. Coast Guard Technical Report 78-2.


VANCOUVER I.
WASHINGTON
OREGON
JANUARY
MEAN SEA CURRENT
* INSUFFICIENT DATA
017/.01
355/.02
053/.02
080/.01
001/.01
355/.02
295/.03
100/.01
068/.01
085/.03
110/.02
092/.01
358/.03
347/.02
.00
137/.03
143/.02
018/.01
347/.01
331/.02
176/.02
.00
015/.01
193/.01
107/.01
071/.01
.00
062/.02
055/.01
50°
48°
N
46°
44°
129°W
127°
125°
123°W

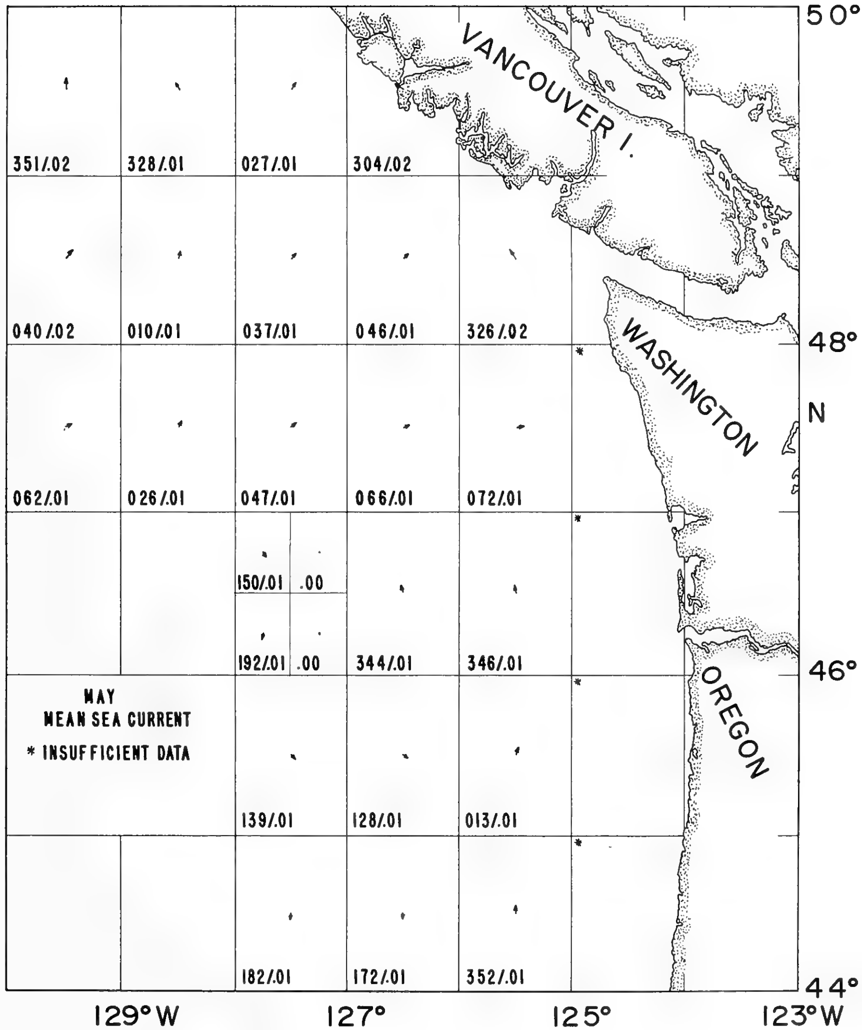

VANCOUVER I.
WASHINGTON
OREGON
264/.03
326/.04
349/.04
297/.04
101/.03
024/.02
009/.04
356/.02
323/.01
098/.04
062/.03
065/.03
047/.01
.00
FEBRUARY
MEAN SEA CURRENT
* INSUFFICIENT DATA
103/.01
122/.01
.00
110/.01
100/.01
.00
115/.01
090/.01
.00
50°
48°
N
46°
44°
129°W
127°
125°
123°W



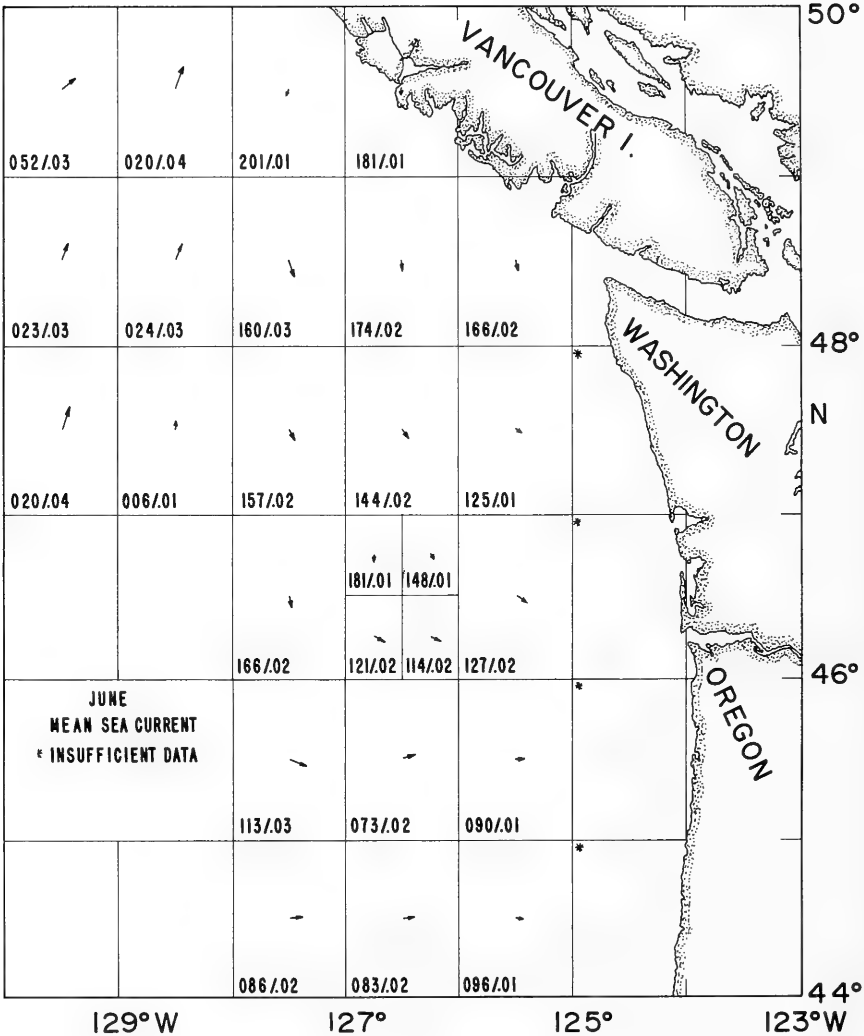
VANCOUVER I.
WASHINGTON
OREGON
50°
48°
N
46°
44°
129°W
127°
125°
123°W
320/.03
285/.02
276/.02
356/.01
051/.02
029/.01
037/.01
070/.05
062/.04
047/.03
086/.02
052/.02
126/.03
077/.02
028/.01
076/.04
073/.04
100/.02
137/.01
062/.01
113/.01
071/.01
050/.01
187/.02
146/.01
022/.01
173/.02
014/.02
079/.01
MARCH
MEAN SEA CURRENT
* INSUFFICIENT DATA
189/.02
333/.01
.00
160/.01
061/.01
021/.02
158/.01
010/.01
.00

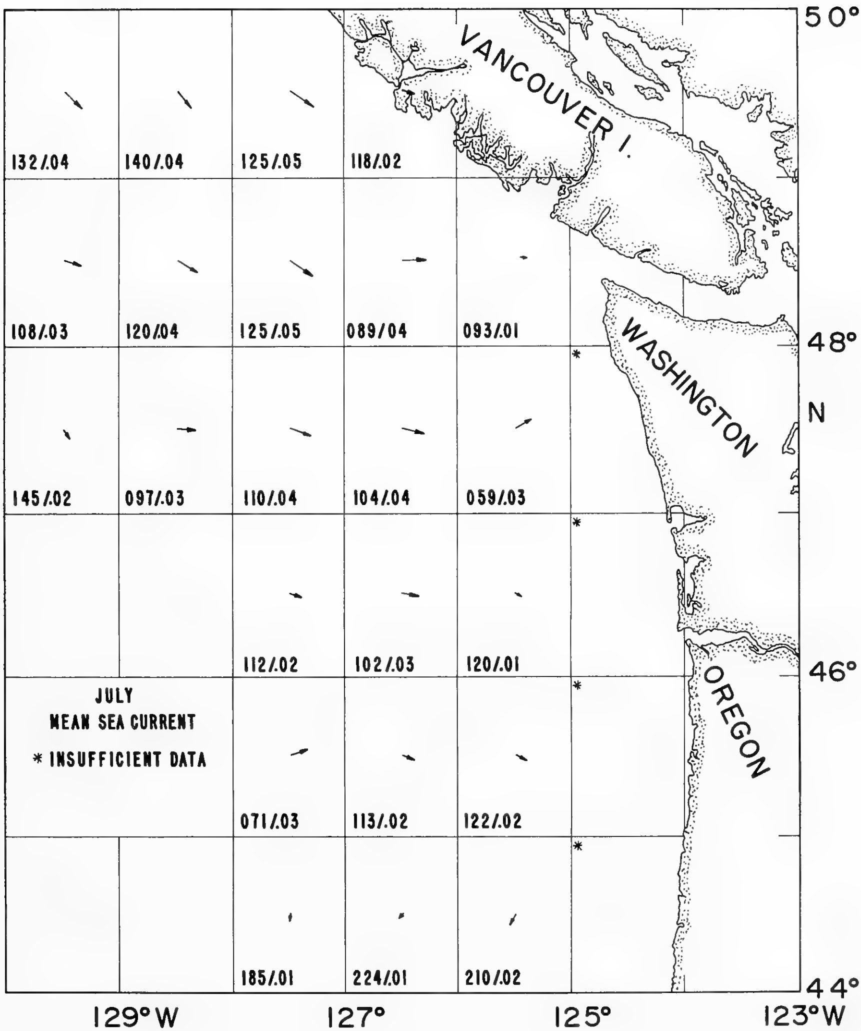


APRIL
MEAN SEA CURRENT
*INSUFFICIENT DATA
VANCOUVER I.
WASHINGTON
OREGON
314/.02
325/.02
350/.02
001/.01
075/.02
051/.02
009/.02
024/.01
043/.01
048/.03
107/.02
040/.02
045/.01
045/.01
061/.02
037/.01
042/.01
022/.01
342/.02
001/.02
043/.01
026/.01
018/.02
50°
48°
N
46°
44°
129° W
127°
125°
123°W

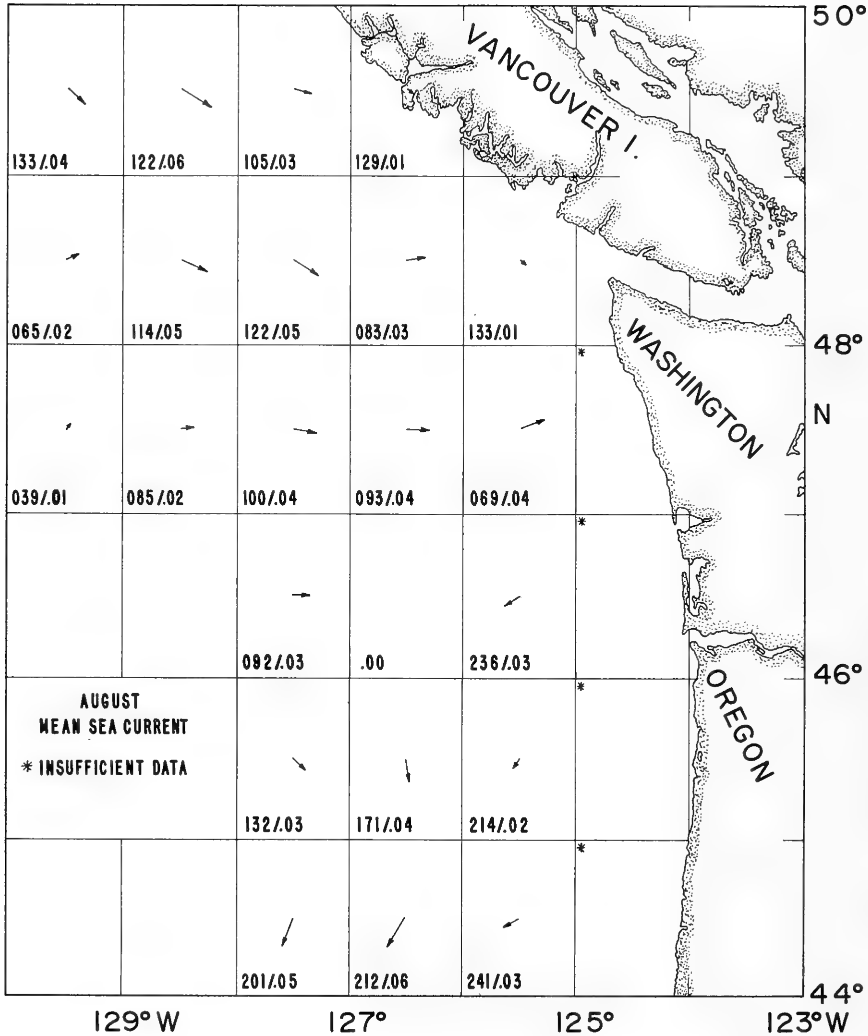


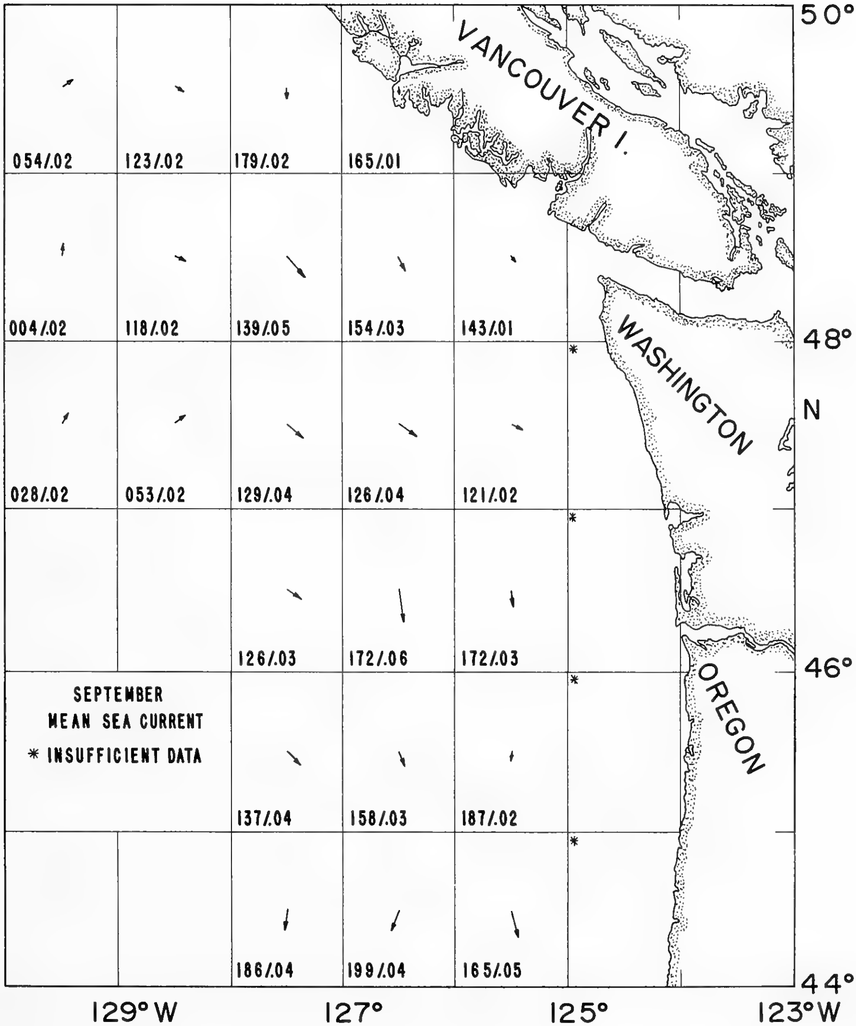
VANCOUVER I.
WASHINGTON
OREGON
50°
48°
N
46°
44°
129° W
127°
125°
123°W
351/.02
328/.01
027/.01
304/.02
040/.02
010/.01
037/.01
046/.01
326/.02
062/.01
026/.01
047/.01
066/.01
072/.01
150/.01
.00
192/.01
.00
344/.01
346/.01
MAY
MEAN SEA CURRENT
* INSUFFICIENT DATA
139/.01
128/.01
013/.01
182/.01
172/.01
352/.01


VANCOUVER I.
WASHINGTON
OREGON
50°
48°
N
46°
44°
129°W
127°
125°
123°W
052/.03
020/.04
201/.01
181/.01
023/.03
024/.03
160/.03
174/.02
166/.02
020/.04
006/.01
157/.02
144/.02
125/.01
181/.01
148/.01
166/.02
121/.02
114/.02
127/.02
JUNE
MEAN SEA CURRENT
* INSUFFICIENT DATA
113/.03
073/.02
090/.01
086/.02
083/.02
096/.01

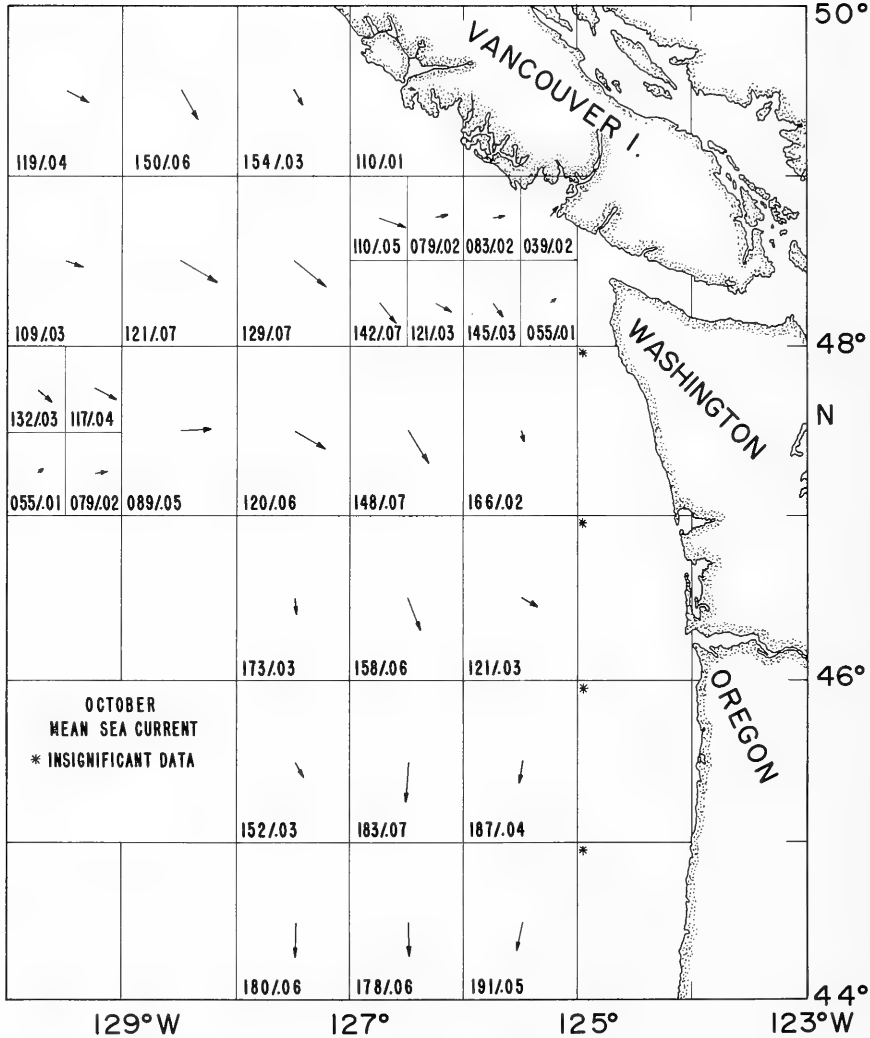


50°
48°
N
46°
44°
129°W
127°
125°
123°W
VANCOUVER I.
WASHINGTON
OREGON
132/.04
140/.04
125/.05
118/.02
108/.03
120/.04
125/.05
089/04
093/.01
145/.02
097/.03
110/.04
104/.04
059/.03
112/.02
102/.03
120/.01
071/.03
113/.02
122/.02
185/.01
224/.01
210/.02
JULY
MEAN SEA CURRENT
* INSUFFICIENT DATA

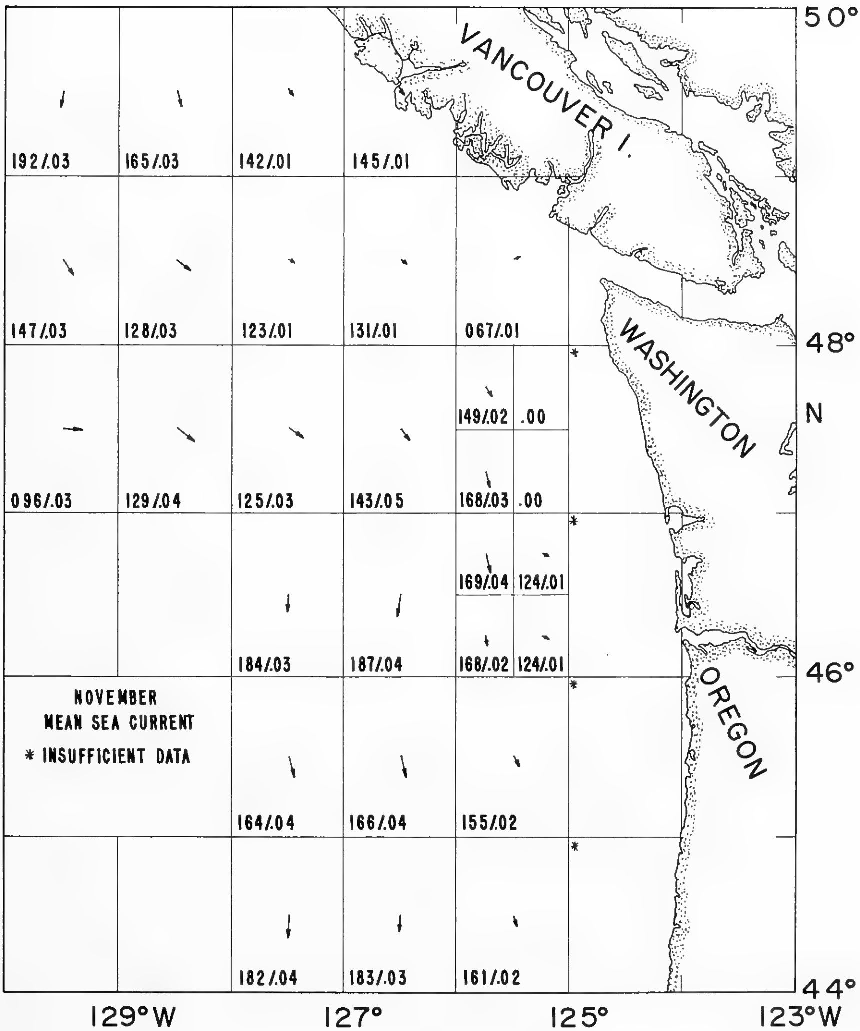

50°
48°
N
46°
44°
129° W
127°
125°
123°W
VANCOUVER I.
WASHINGTON
OREGON
AUGUST
MEAN SEA CURRENT
* INSUFFICIENT DATA
133/.04
122/.06
105/.03
129/.01
065/.02
114/.05
122/.05
083/.03
133/.01
039/.01
085/.02
100/.04
093/.04
069/.04
092/.03
.00
236/.03
132/.03
171/.04
214/.02
201/.05
212/.06
241/.03

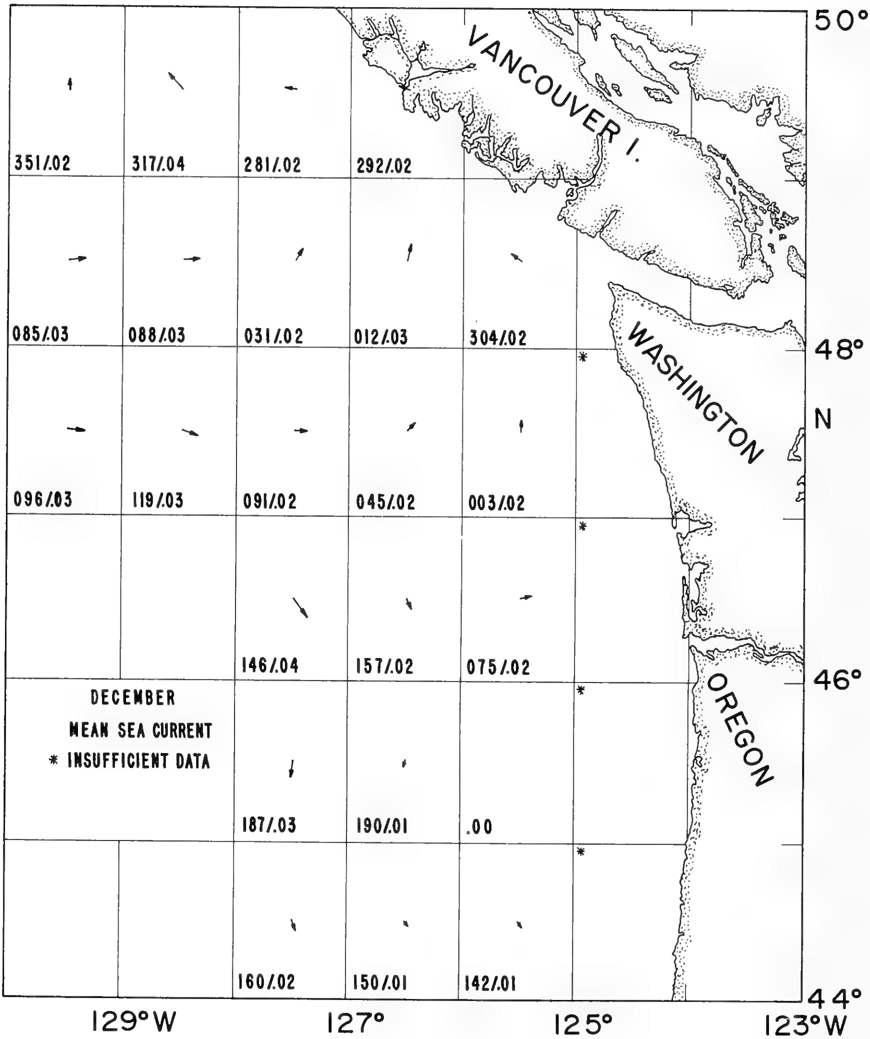


VANCOUVER I.
WASHINGTON
OREGON
50°
48°
N
46°
44°
129° W
127°
125°
123°W
054/.02
123/.02
179/.02
165/.01
004/.02
118/.02
139/.05
154/.03
143/.01
028/.02
053/.02
129/.04
126/.04
121/.02
126/.03
172/.06
172/.03
SEPTEMBER
MEAN SEA CURRENT
* INSUFFICIENT DATA
137/.04
158/.03
187/.02
186/.04
199/.04
165/.05

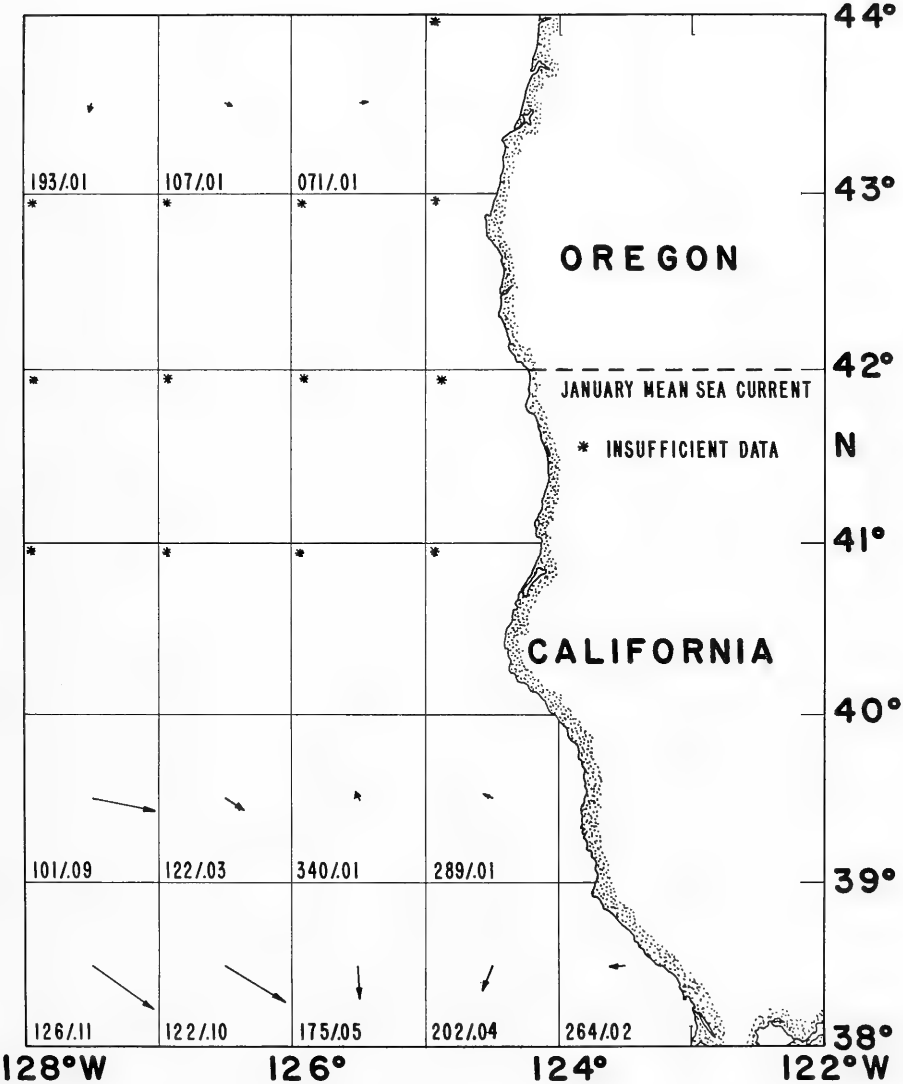


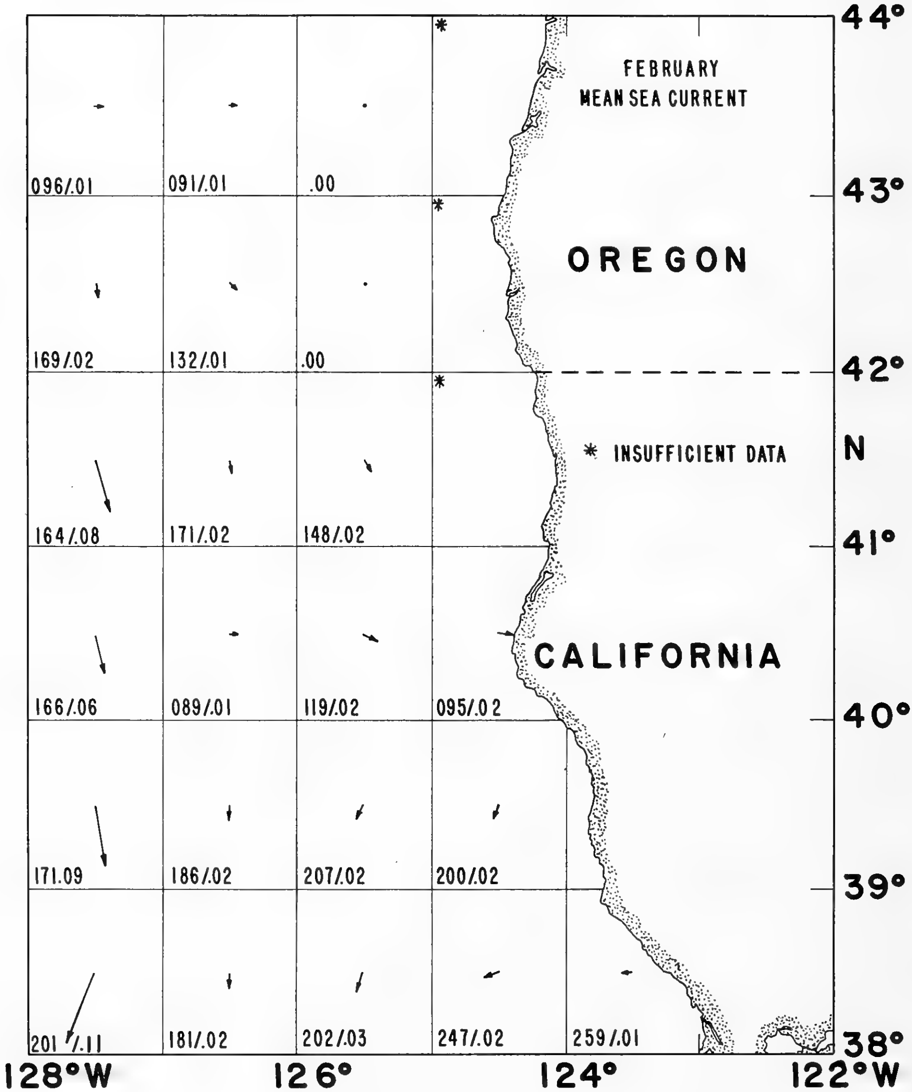
VANCOUVER I.
WASHINGTON
OREGON
50°
48°
N
46°
44°
129°W
127°
125°
123°W
119/.04
150/.06
154/.03
110/.01
110/.05
079/.02
083/.02
039/.02
109/.03
121/.07
129/.07
142/.07
121/.03
145/.03
055/.01
132/.03
117/.04
055/.01
079/.02
089/.05
120/.06
148/.07
166/.02
173/.03
158/.06
121/.03
OCTOBER
MEAN SEA CURRENT
* INSIGNIFICANT DATA
152/.03
183/.07
187/.04
180/.06
178/.06
191/.05

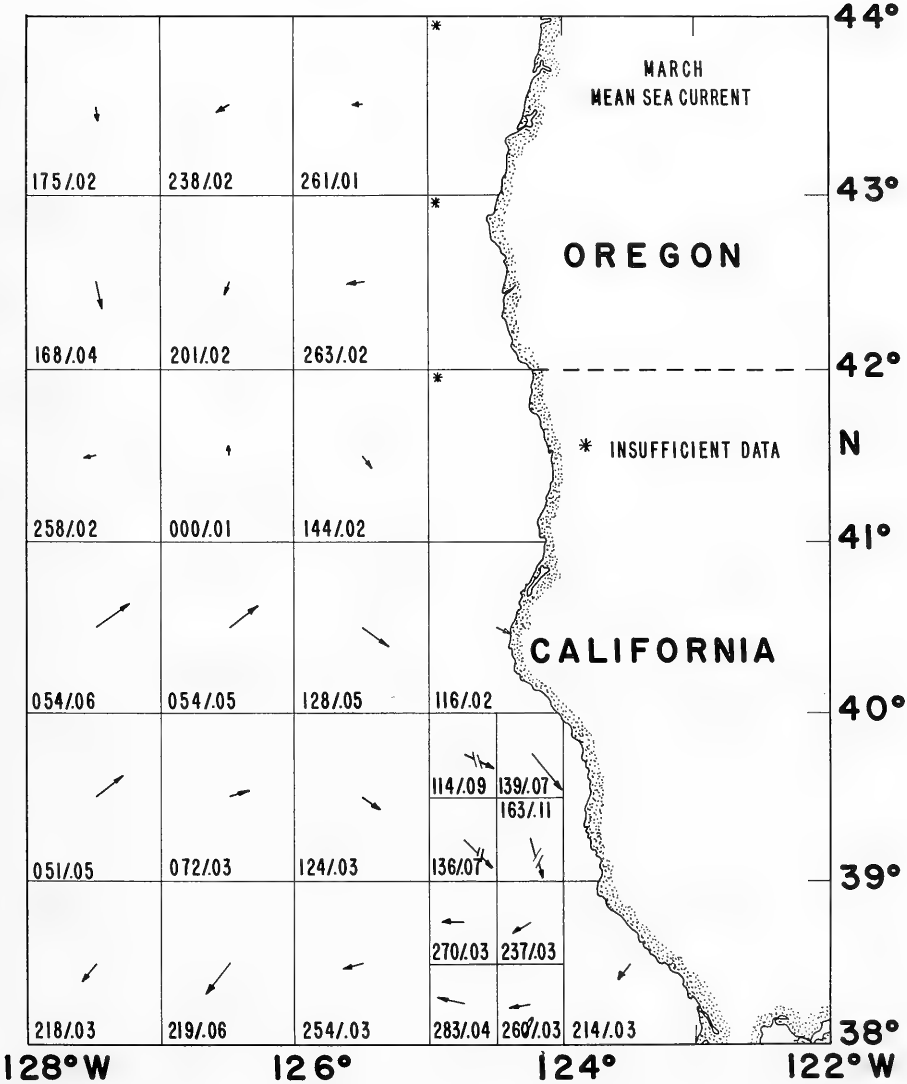

VANCOUVER I.
WASHINGTON
OREGON
50°
48°
N
46°
44°
129°W
127°
125°
123°W
192/.03
165/.03
142/.01
145/.01
147/.03
128/.03
123/.01
131/.01
067/.01
096/.03
129/.04
125/.03
143/.05
149/.02
.00
168/.03
.00
169/.04
124/.01
168/.02
124/.01
184/.03
187/.04
164/.04
166/.04
155/.02
182/.04
183/.03
161/.02
NOVEMBER
MEAN SEA CURRENT
* INSUFFICIENT DATA



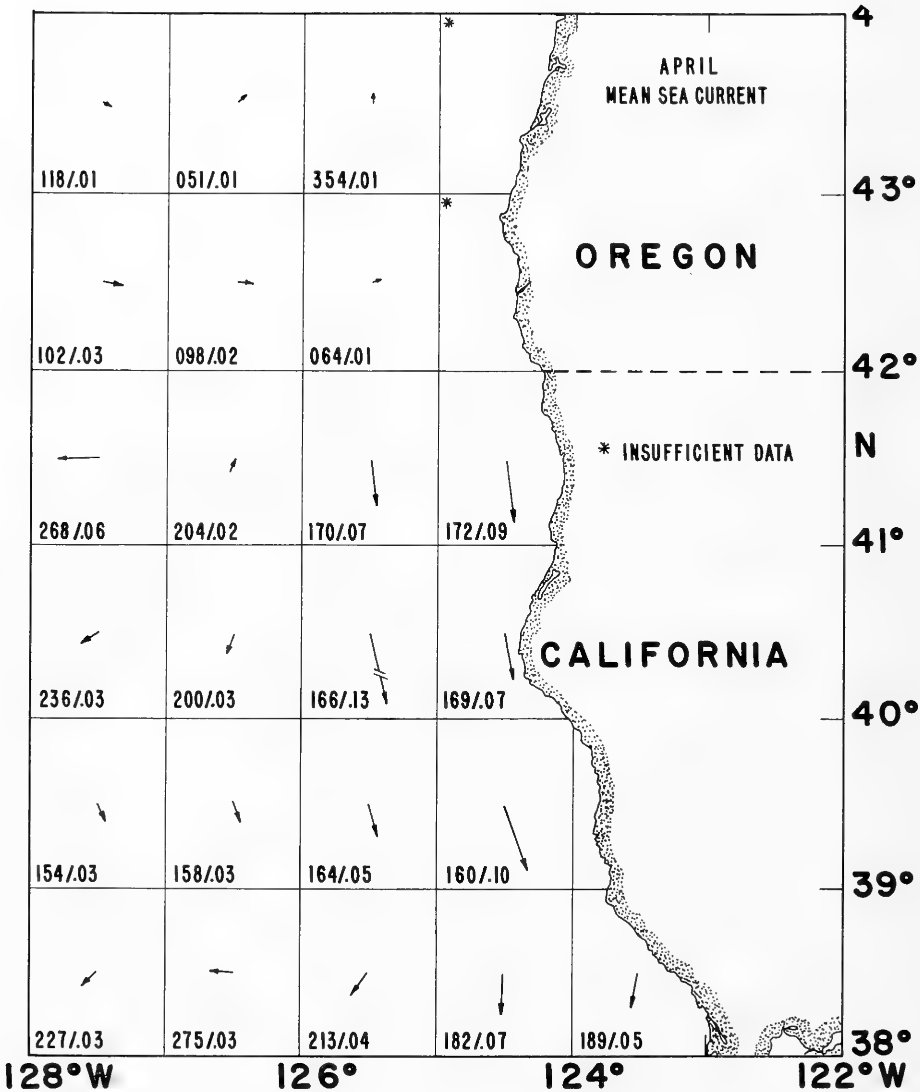
VANCOUVER I.
WASHINGTON
OREGON
50°
48°
N
46°
44°
129°W
127°
125°
123°W
351/.02
317/.04
281/.02
292/.02
085/.03
088/.03
031/.02
012/.03
304/.02
096/.03
119/.03
091/.02
045/.02
003/.02
146/.04
157/.02
075/.02
187/.03
190/.01
.00
160/.02
150/.01
142/.01
DECEMBER
MEAN SEA CURRENT
* INSUFFICIENT DATA

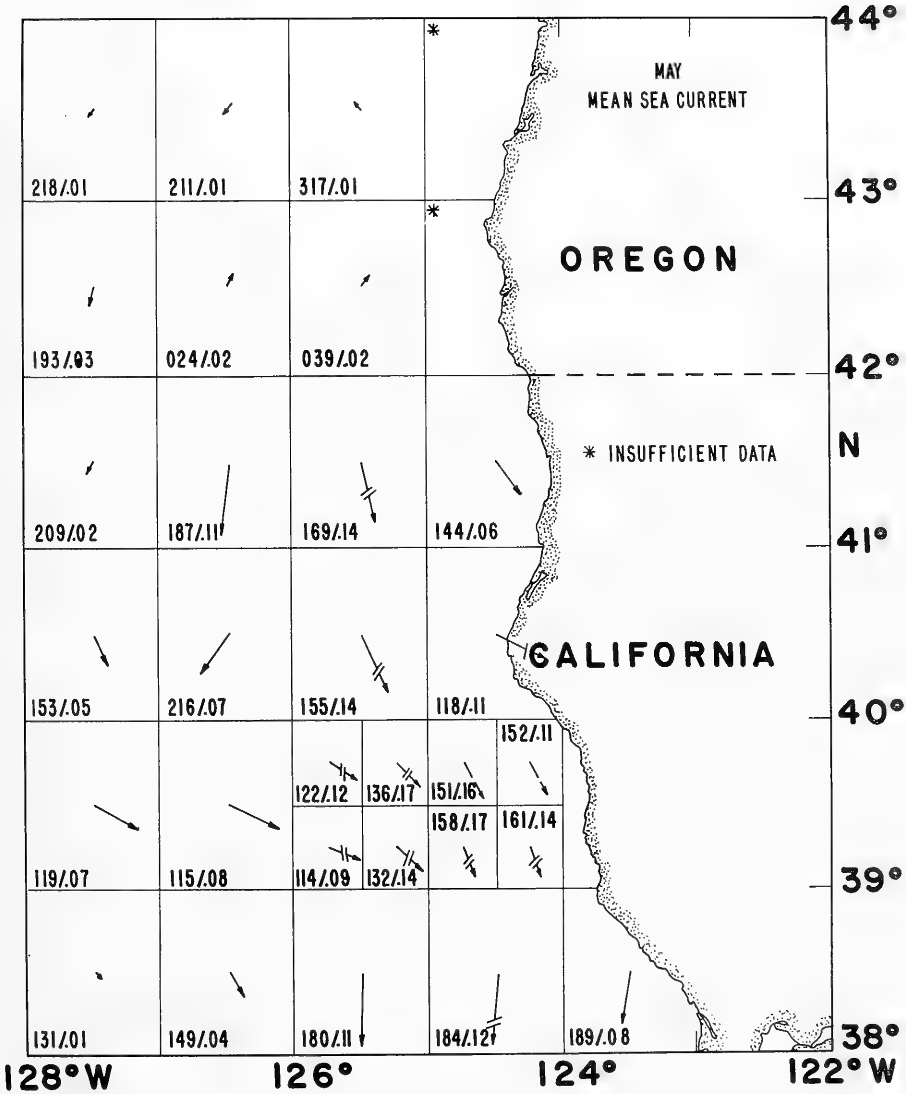

44°
43°
42°
41°
40°
39°
38°
N
128°W
126°
124°
122°W
OREGON
CALIFORNIA
JANUARY MEAN SEA CURRENT
* INSUFFICIENT DATA
193/.01
107/.01
071/.01
101/.09
122/.03
340/.01
289/.01
126/.11
122/.10
175/.05
202/.04
264/.02

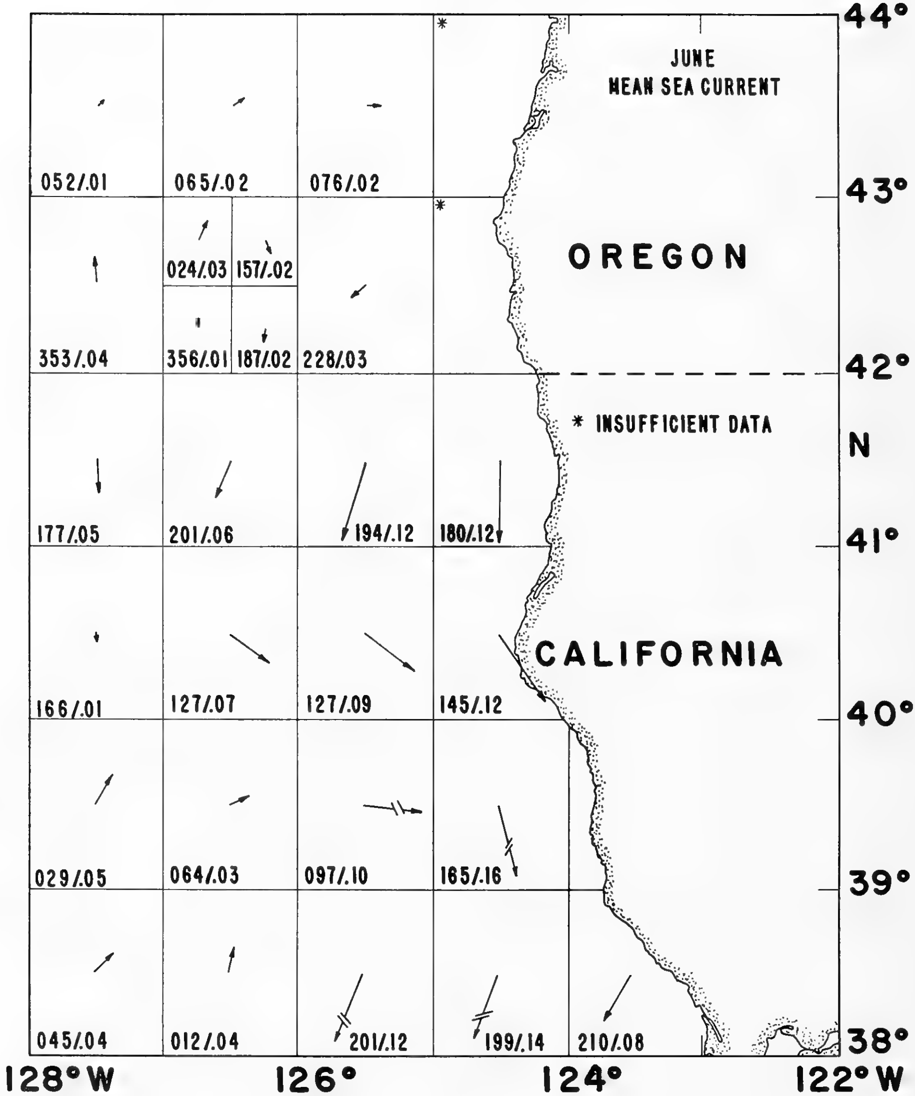

FEBRUARY
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
44°
43°
42°
N
41°
40°
39°
38°
128°W
126°
124°
122°W
096/.01
091/.01
.00
169/.02
132/.01
.00
164/.08
171/.02
148/.02
166/.06
089/.01
119/.02
095/.02
171.09
186/.02
207/.02
200/.02
201/.11
181/.02
202/.03
247/.02
259/.01



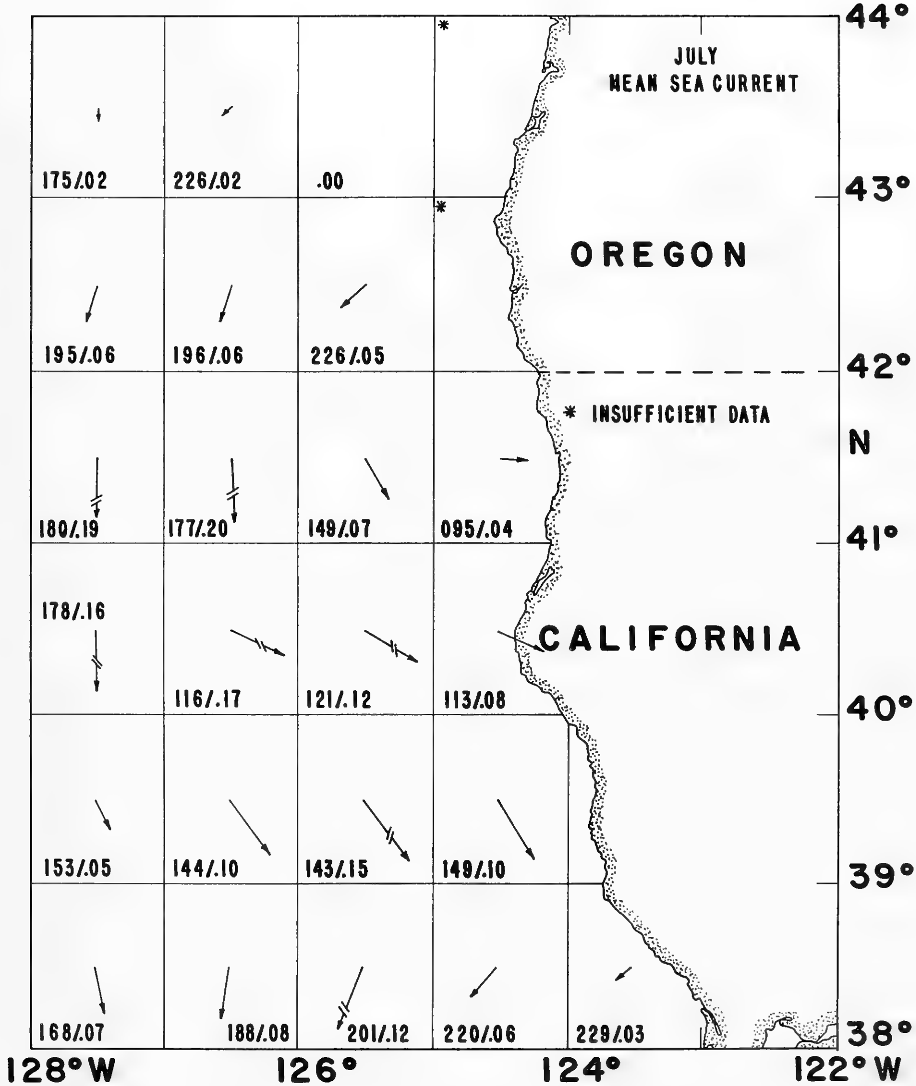
MARCH
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
44°
43°
42°
N
41°
40°
39°
38°
128° W
126°
124°
122° W
175/.02
238/.02
261/.01
168/.04
201/.02
263/.02
258/.02
000/.01
144/.02
054/.06
054/.05
128/.05
116/.02
051/.05
072/.03
124/.03
114/.09
139/.07
163/.11
136/.07
218/.03
219/.06
254/.03
270/.03
237/.03
283/.04
260/.03
214/.03

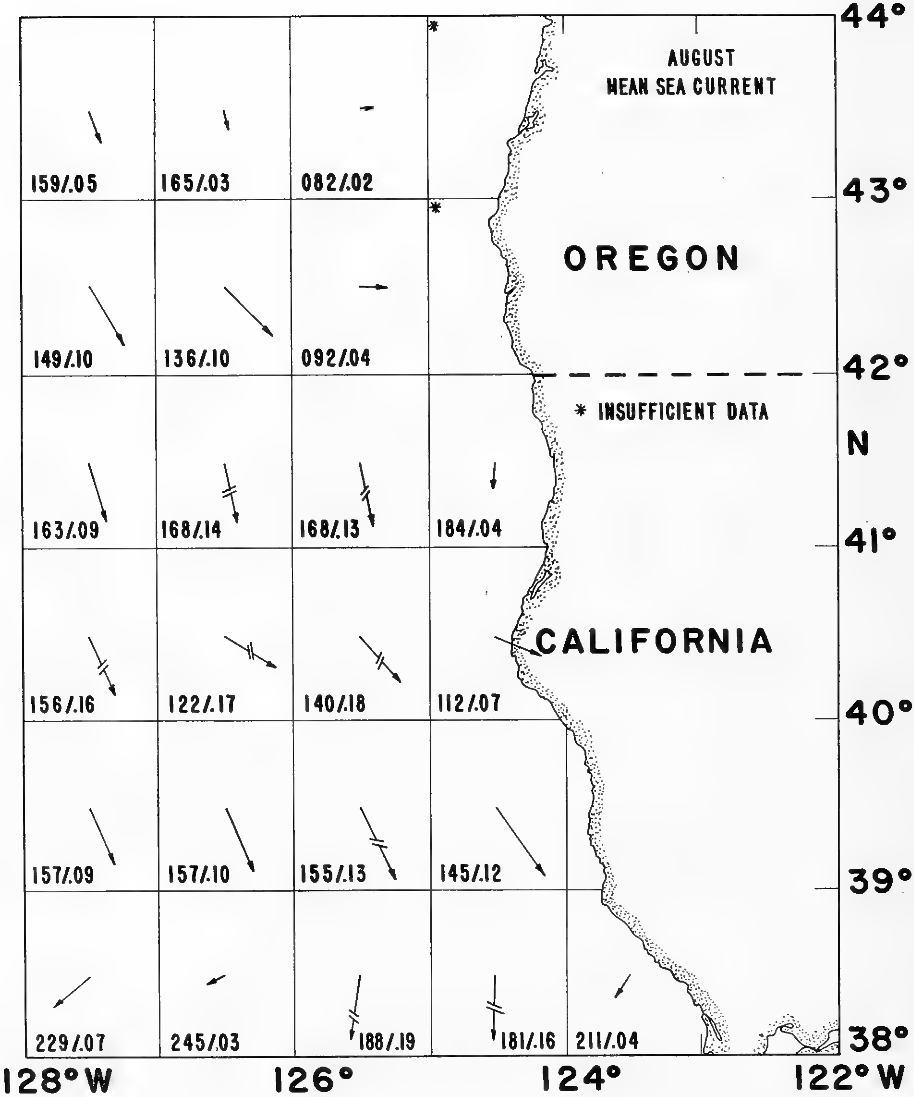

APRIL
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
118/.01
051/.01
354/.01
102/.03
098/.02
064/.01
268/.06
204/.02
170/.07
172/.09
236/.03
200/.03
166/.13
169/.07
154/.03
158/.03
164/.05
160/.10
227/.03
275/.03
213/.04
182/.07
189/.05
4
43°
42°
N
41°
40°
39°
38°
128°W
126°
124°
122°W


MAY
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
44°
43°
42°
N
41°
40°
39°
38°
128°W
126°
124°
122°W
218/.01
211/.01
317/.01
193/.03
024/.02
039/.02
209/.02
187/.11
169/.14
144/.06
153/.05
216/.07
155/.14
118/.11
152/.11
122/.12
136/.17
151/.16
158/.17
161/.14
119/.07
115/.08
114/.09
132/.14
131/.01
149/.04
180/.11
184/.12
189/.08

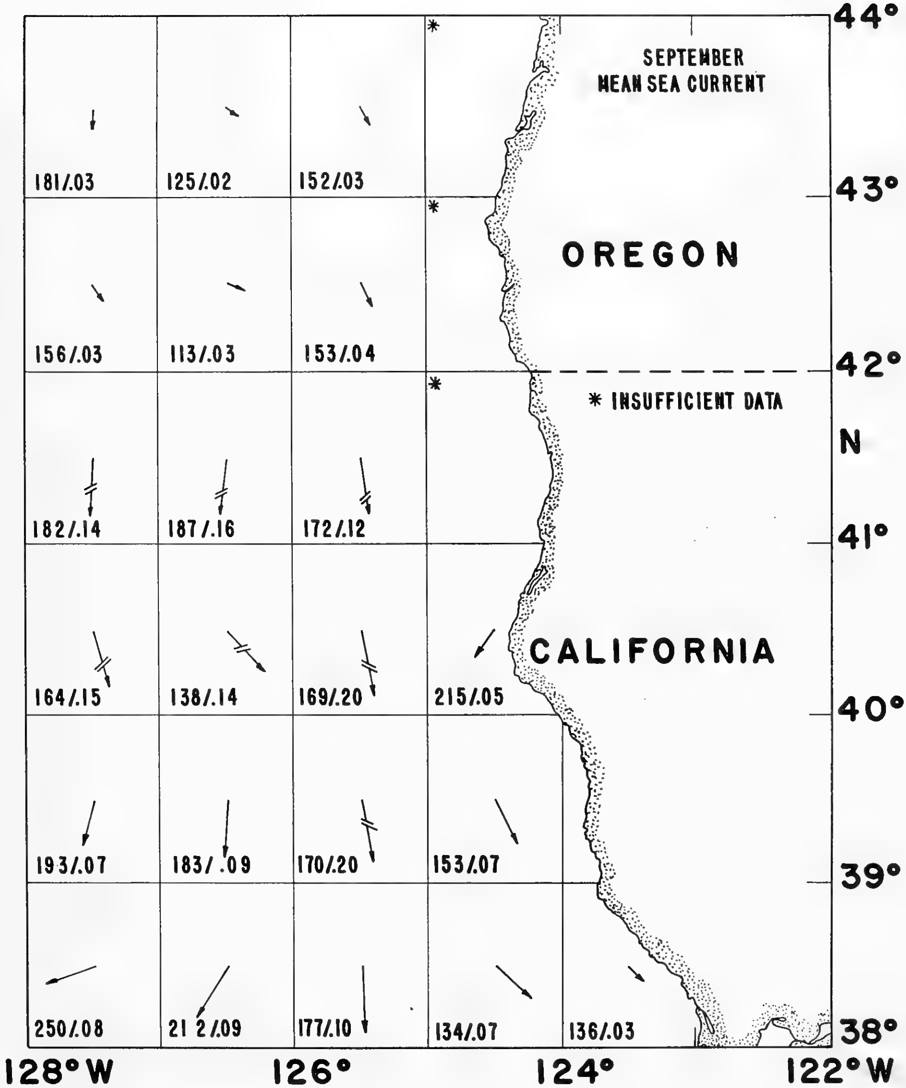


JUNE
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
052/.01
065/.02
076/.02
353/.04
024/.03
157/.02
356/.01
187/.02
228/.03
177/.05
201/.06
194/.12
180/.12
166/.01
127/.07
127/.09
145/.12
029/.05
064/.03
097/.10
165/.16
045/.04
012/.04
201/.12
199/.14
210/.08
44°
43°
42°
N
41°
40°
39°
38°
128° W
126°
124°
122° W

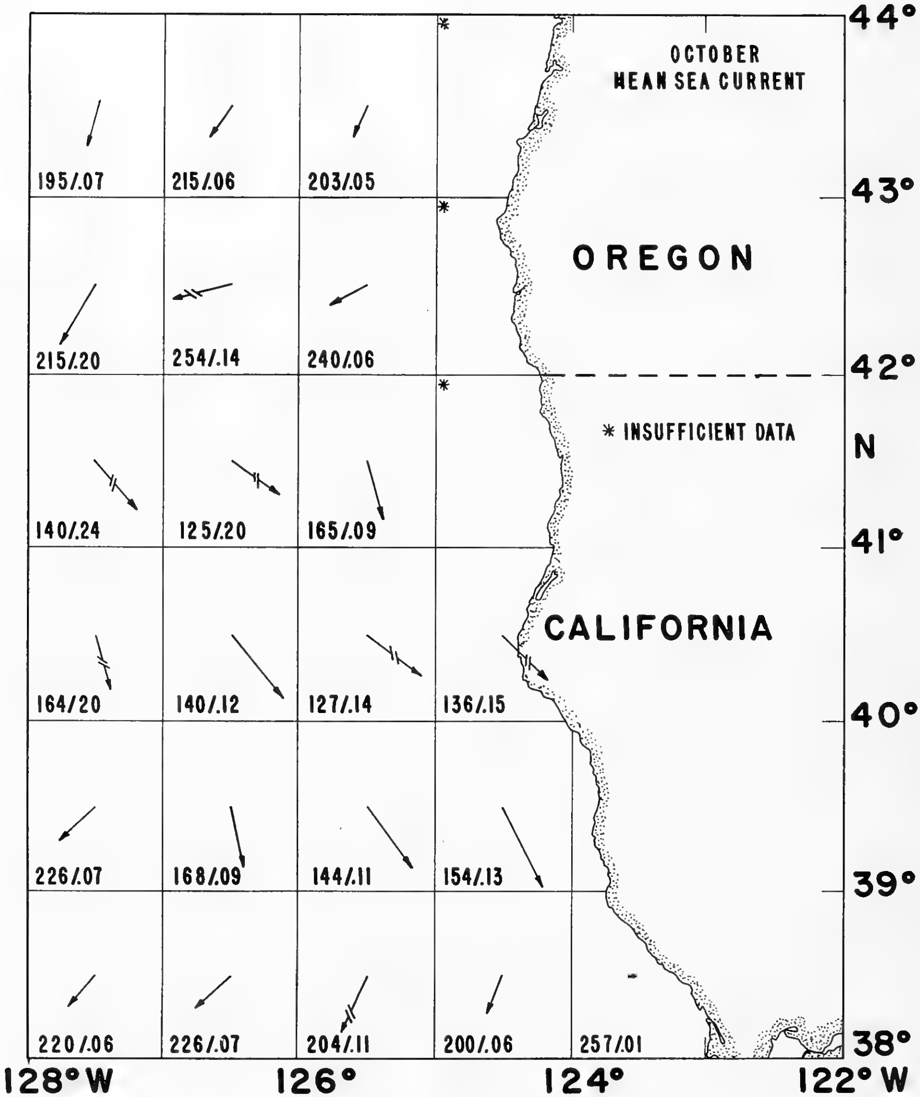

JULY
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
44°
43°
42°
N
41°
40°
39°
38°
128°W
126°
124°
122°W
175/.02
226/.02
.00
195/.06
196/.06
226/.05
180/.19
177/.20
149/.07
095/.04
178/.16
116/.17
121/.12
113/.08
153/.05
144/.10
143/.15
149/.10
168/.07
188/.08
201/.12
220/.06
229/.03

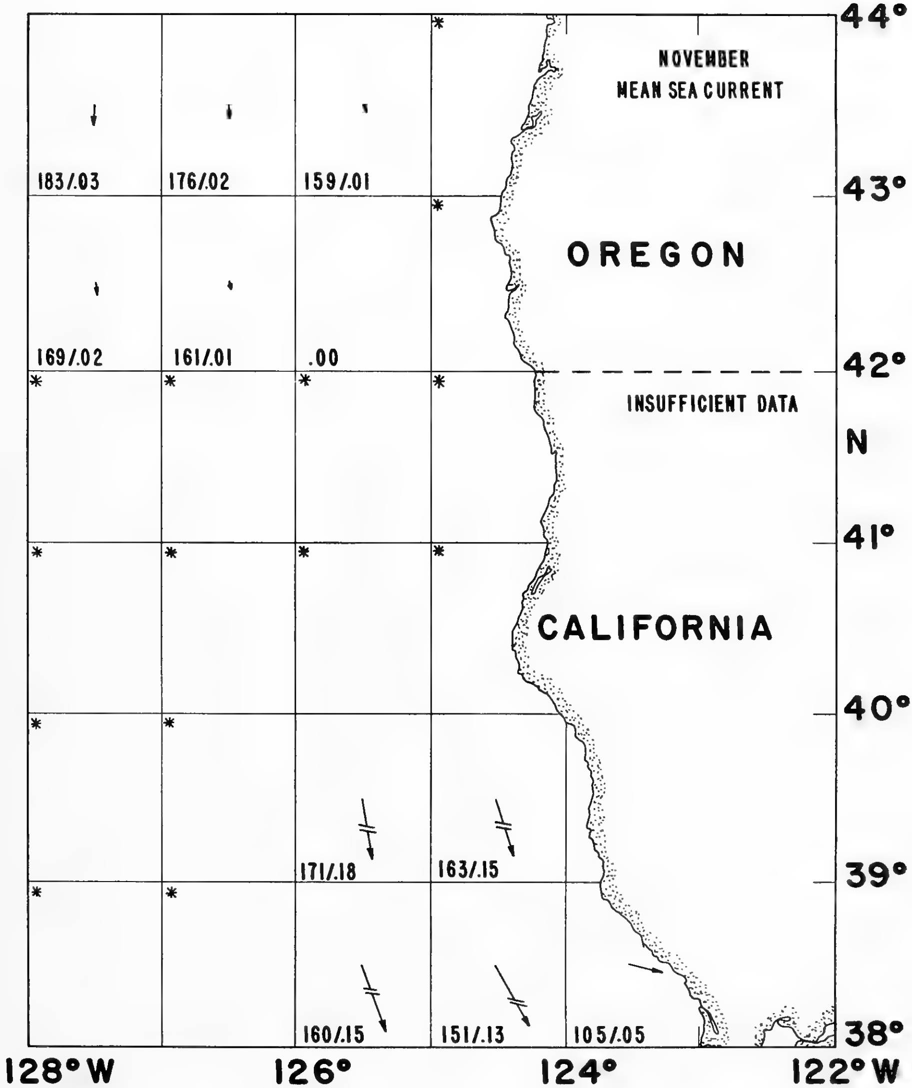


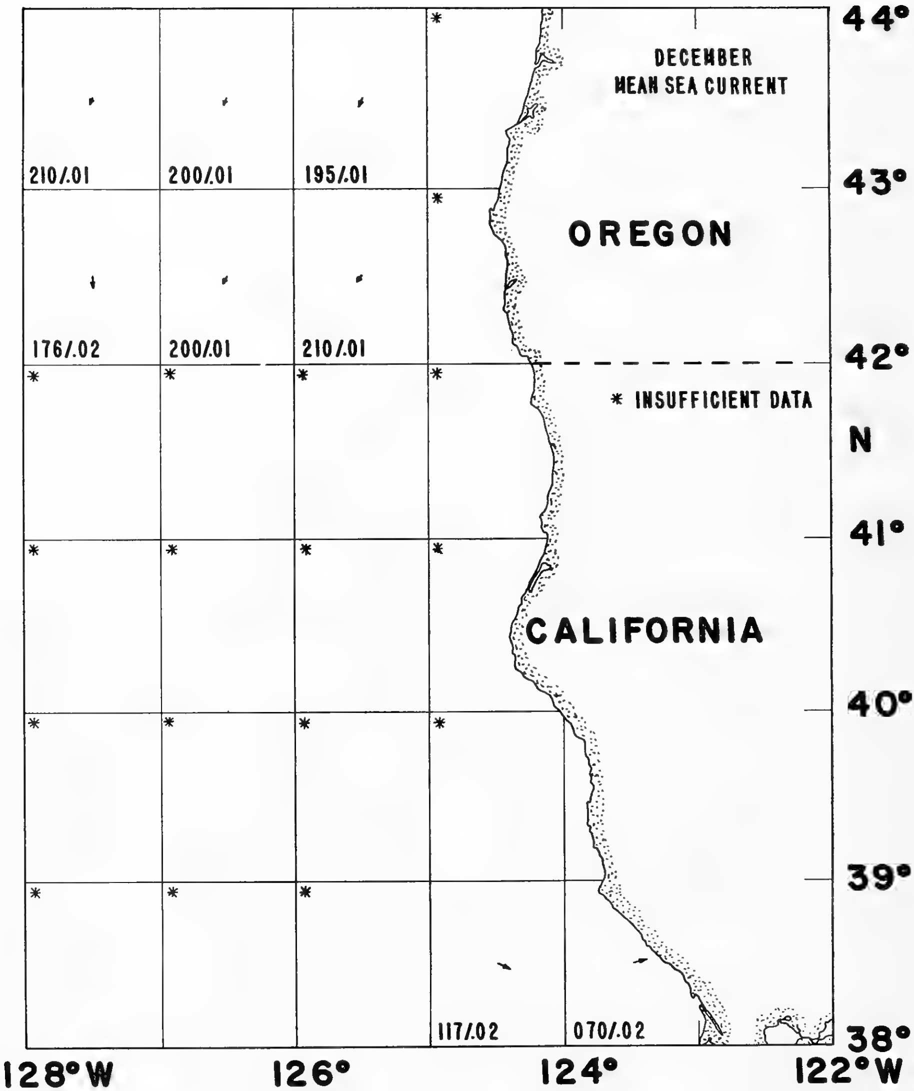
AUGUST
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
44°
43°
42°
41°
40°
39°
38°
N
128° W
126°
124°
122° W
159/.05
165/.03
082/.02
149/.10
136/.10
092/.04
163/.09
168/.14
168/.13
184/.04
156/.16
122/.17
140/.18
112/.07
157/.09
157/.10
155/.13
145/.12
229/.07
245/.03
188/.19
181/.16
211/.04

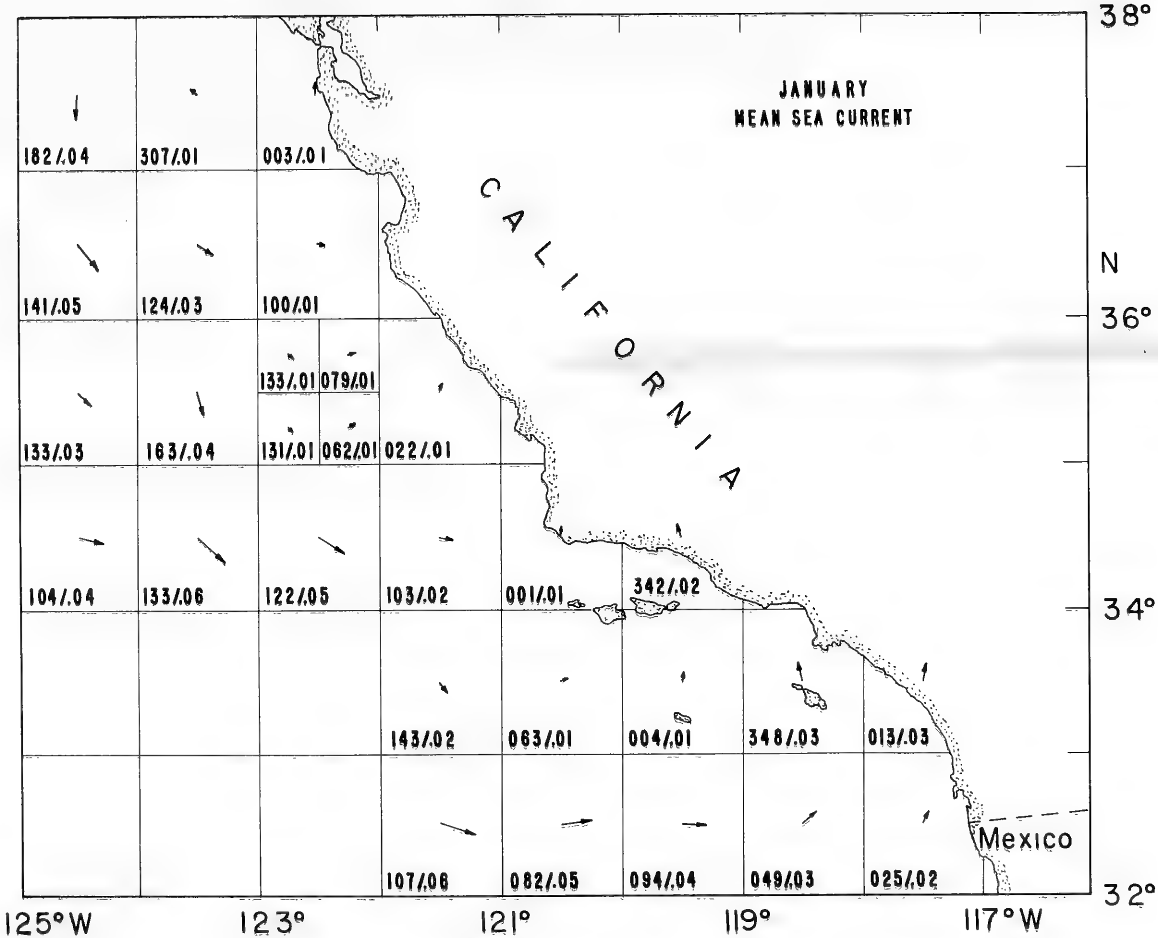


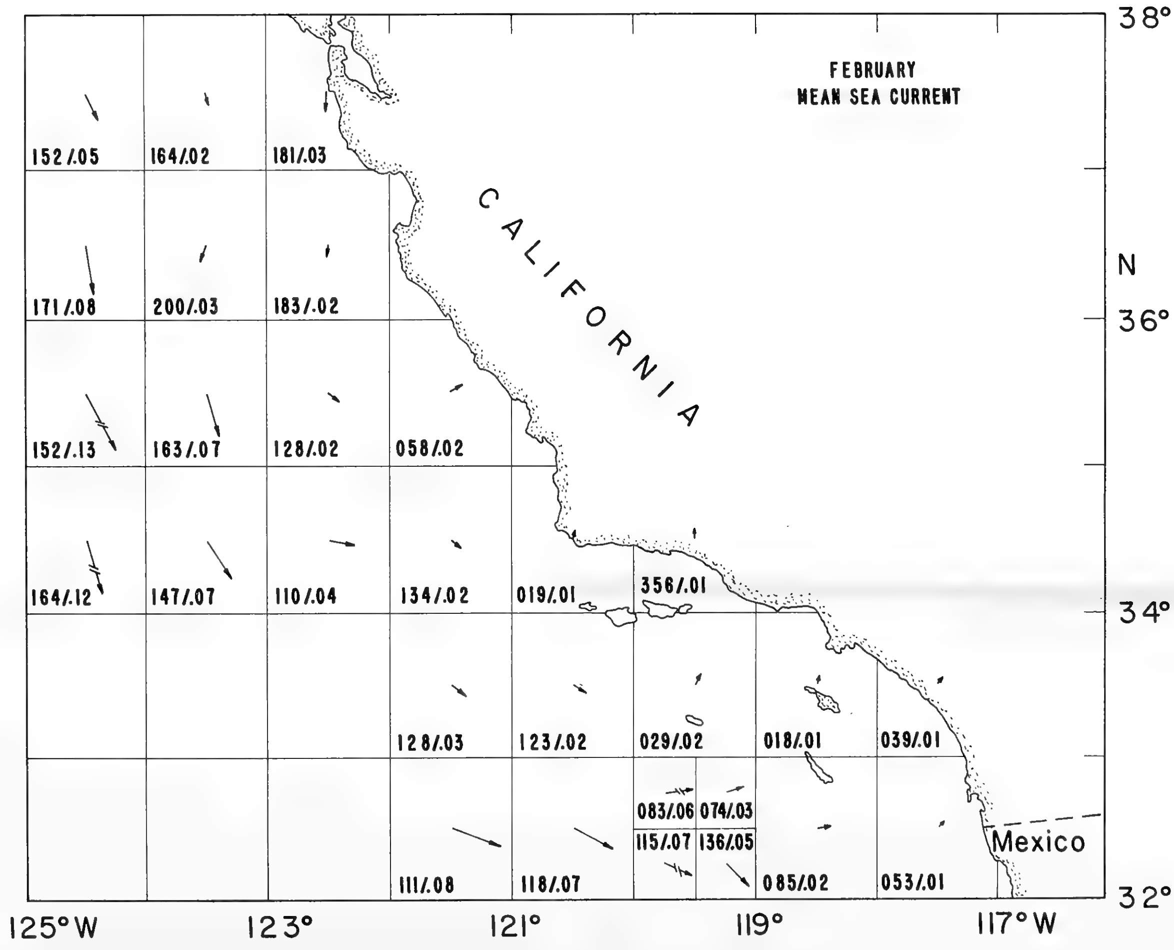
SEPTEMBER
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
44°
43°
42°
N
41°
40°
39°
38°
128° W
126°
124°
122° W
181/.03
125/.02
152/.03
156/.03
113/.03
153/.04
182/.14
187/.16
172/.12
164/.15
138/.14
169/.20
215/.05
193/.07
183/.09
170/.20
153/.07
250/.08
212/.09
177/.10
134/.07
136/.03


OCTOBER
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
44°
43°
42°
N
41°
40°
39°
38°
128° W
126°
124°
122° W
195/.07
215/.06
203/.05
215/.20
254/.14
240/.06
140/.24
125/.20
165/.09
164/20
140/.12
127/.14
136/.15
226/.07
168/.09
144/.11
154/.13
220/.06
226/.07
204/.11
200/.06
257/.01

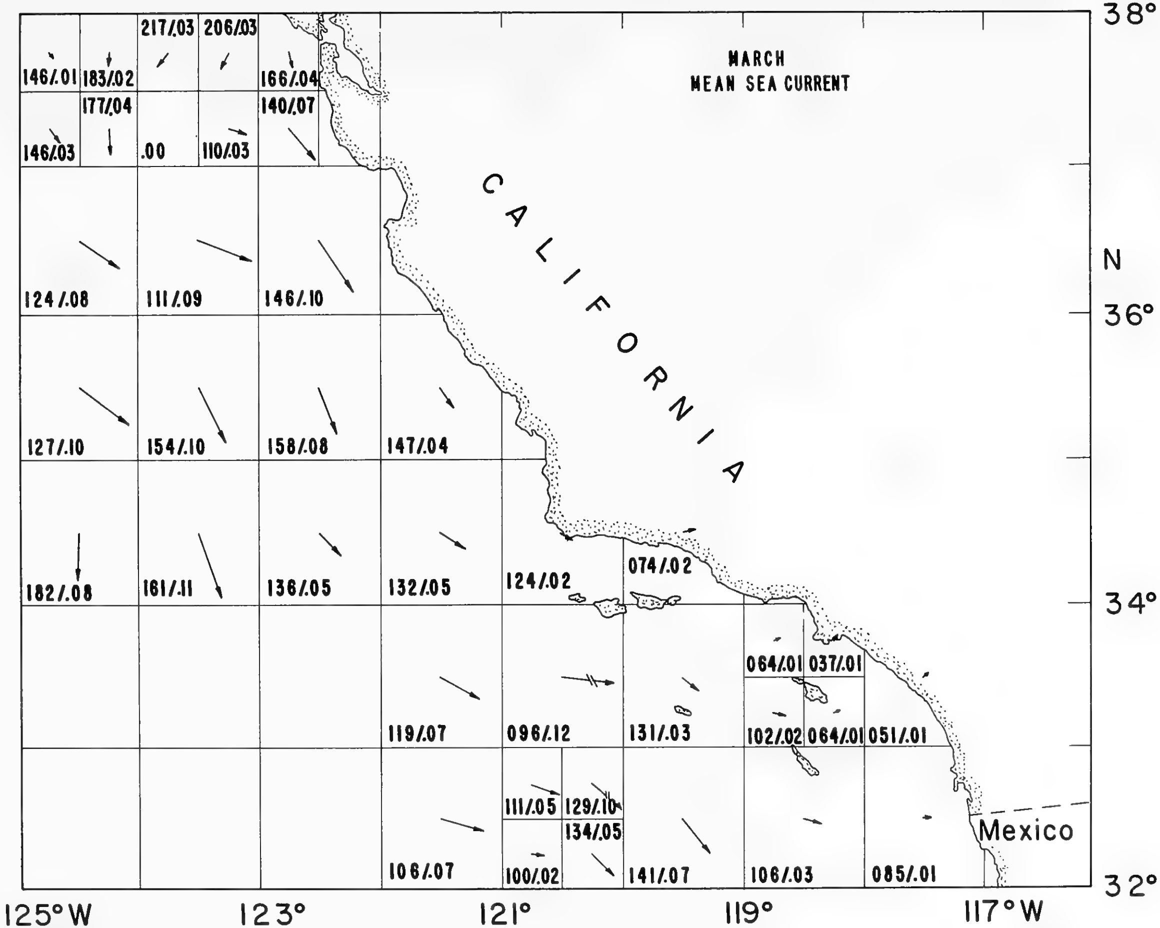

NOVEMBER
MEAN SEA CURRENT
OREGON
CALIFORNIA
INSUFFICIENT DATA
183/.03
176/.02
159/.01
169/.02
161/.01
.00
171/.18
163/.15
160/.15
151/.13
105/.05
44°
43°
42°
N
41°
40°
39°
38°
128° W
126°
124°
122° W


DECEMBER
MEAN SEA CURRENT
OREGON
CALIFORNIA
* INSUFFICIENT DATA
N
210/.01
200/.01
195/.01
176/.02
200/.01
210/.01
117/.02
070/.02
44°
43°
42°
41°
40°
39°
38°
128°W
126°
124°
122°W

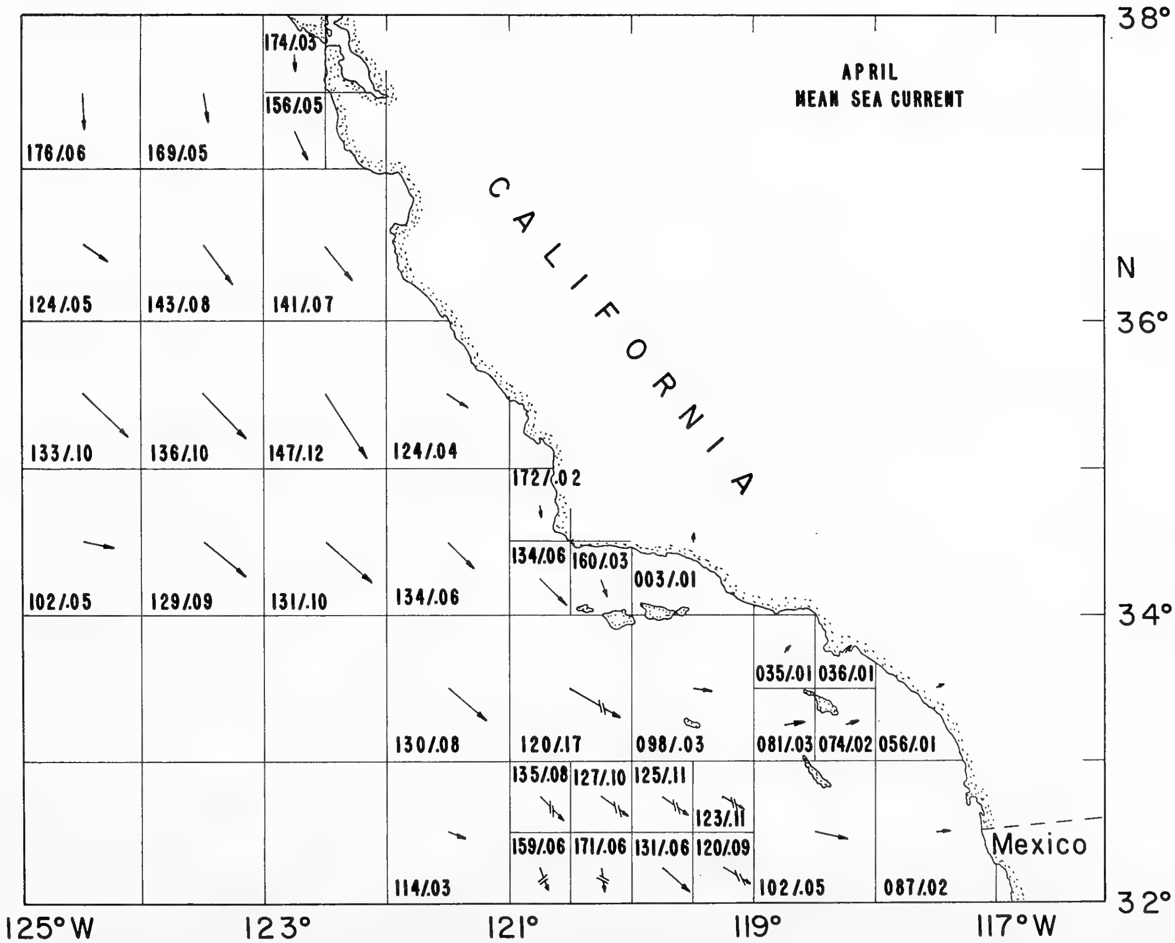

JANUARY
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
N
36°
34°
32°
125°W
123°
121°
119°
117°W
182/.04
307/.01
003/.01
141/.05
124/.03
100/.01
133/.03
163/.04
133/.01
079/.01
131/.01
062/.01
022/.01
104/.04
133/.06
122/.05
103/.02
001/.01
342/.02
143/.02
063/.01
004/.01
348/.03
013/.03
107/.06
082/.05
094/.04
049/.03
025/.02

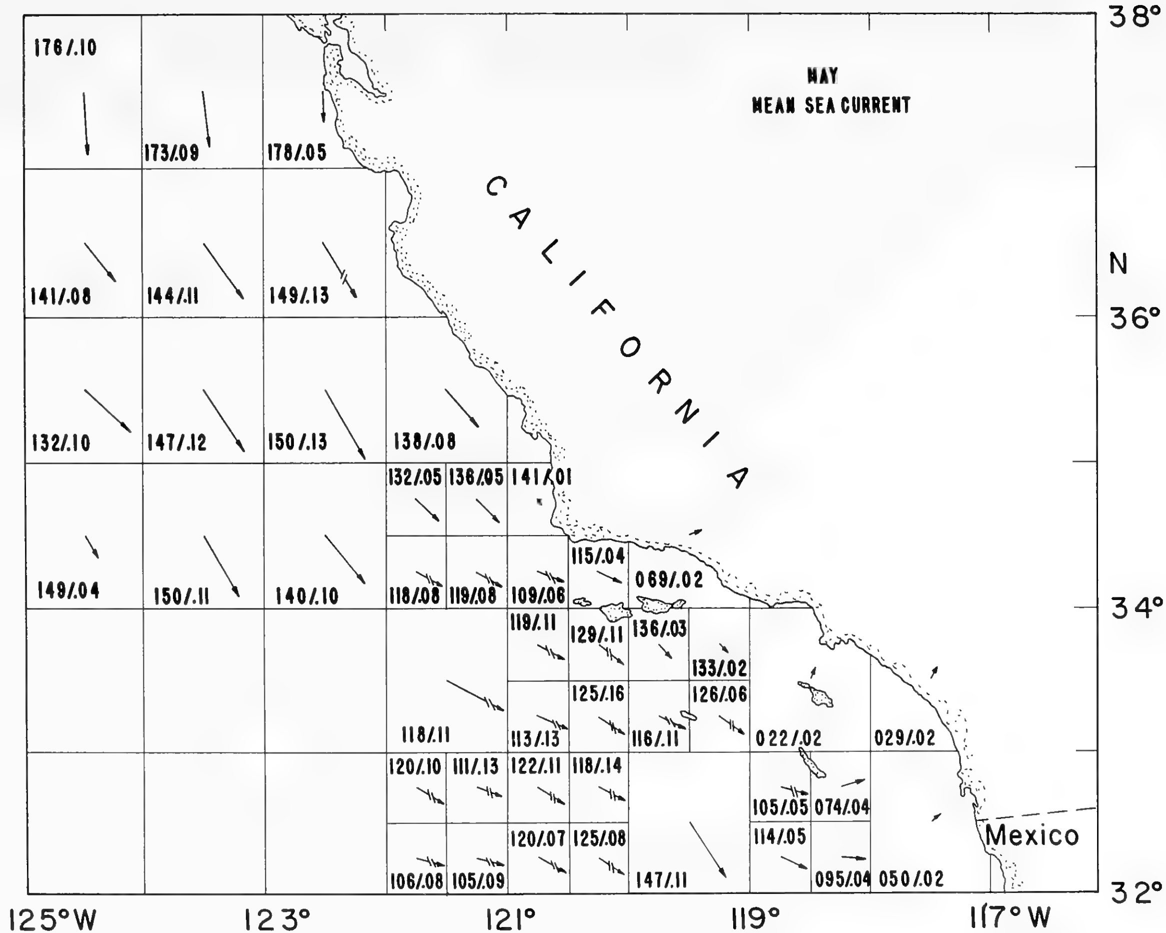


FEBRUARY
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
N
36°
34°
32°
125°W
123°
121°
119°
117°W
152/.05
164/.02
181/.03
171/.08
200/.03
183/.02
152/.13
163/.07
128/.02
058/.02
164/.12
147/.07
110/.04
134/.02
019/.01
356/.01
128/.03
123/.02
029/.02
018/.01
039/.01
083/.06
074/.03
115/.07
136/.05
111/.08
118/.07
085/.02
053/.01

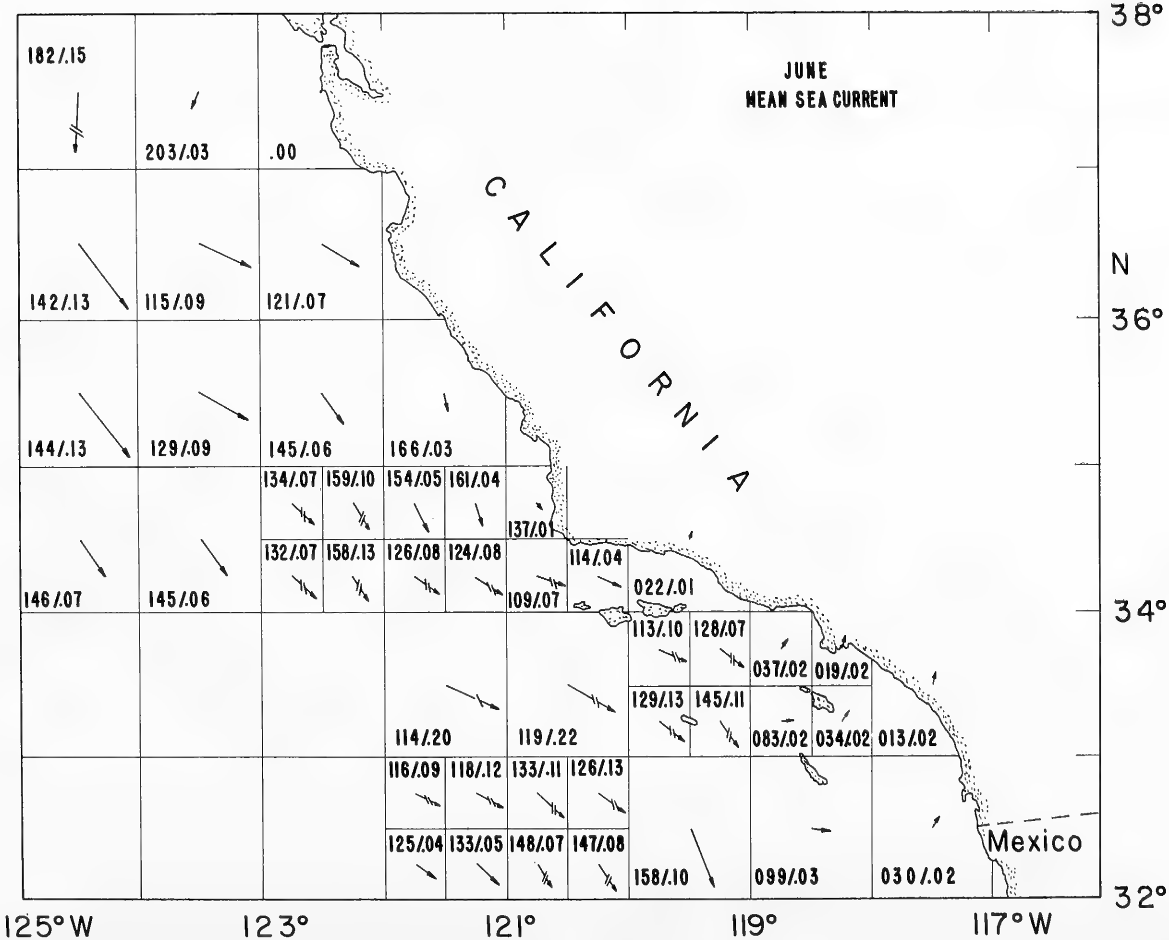


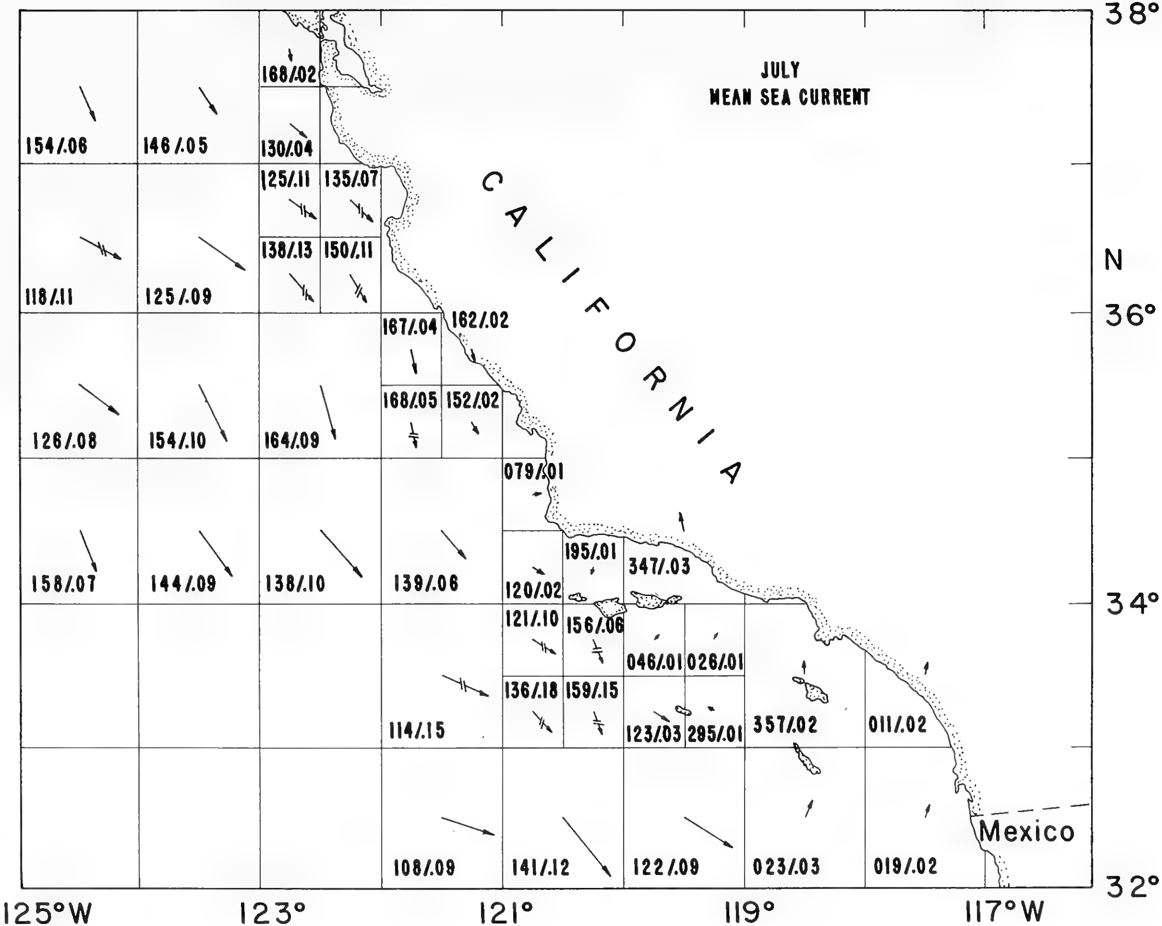
MARCH
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
N
36°
34°
32°
125°W
123°
121°
119°
117°W
146/.01
183/.02
217/.03
206/.03
166/.04
146/.03
177/.04
.00
110/.03
140/.07
124/.08
111/.09
146/.10
127/.10
154/.10
158/.08
147/.04
182/.08
161/.11
136/.05
132/.05
124/.02
074/.02
119/.07
096/.12
131/.03
064/.01
037/.01
102/.02
064/.01
051/.01
106/.07
111/.05
129/.10
134/.05
100/.02
141/.07
106/.03
085/.01

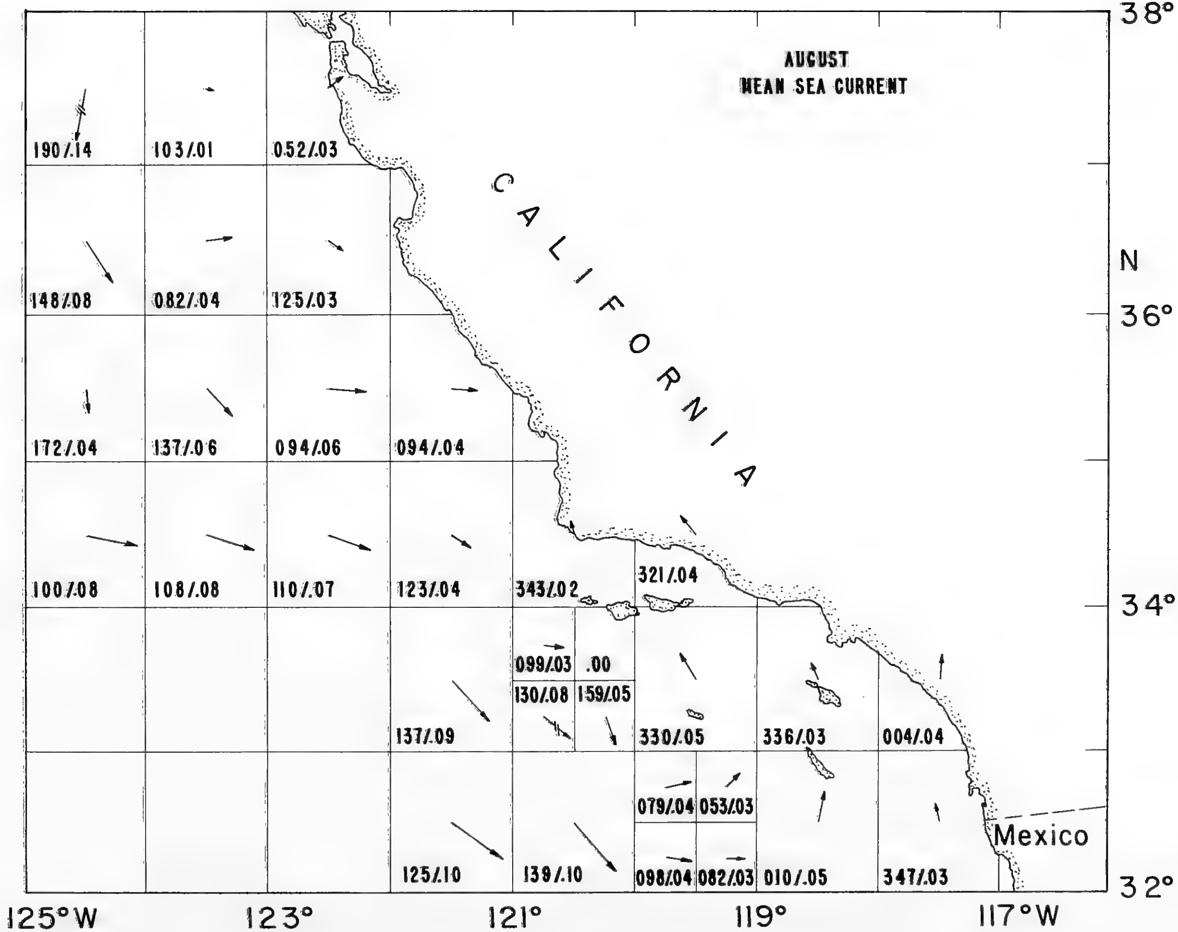

APRIL
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
36°
34°
32°
N
125°W
123°
121°
119°
117°W
174/.03
156/.05
176/.06
169/.05
124/.05
143/.08
141/.07
133/.10
136/.10
147/.12
124/.04
172/.02
102/.05
129/.09
131/.10
134/.06
134/.06
160/.03
003/.01
130/.08
120/.17
098/.03
035/.01
036/.01
081/.03
074/.02
056/.01
135/.08
127/.10
125/.11
123/.11
159/.06
171/.06
131/.06
120/.09
114/.03
102/.05
087/.02

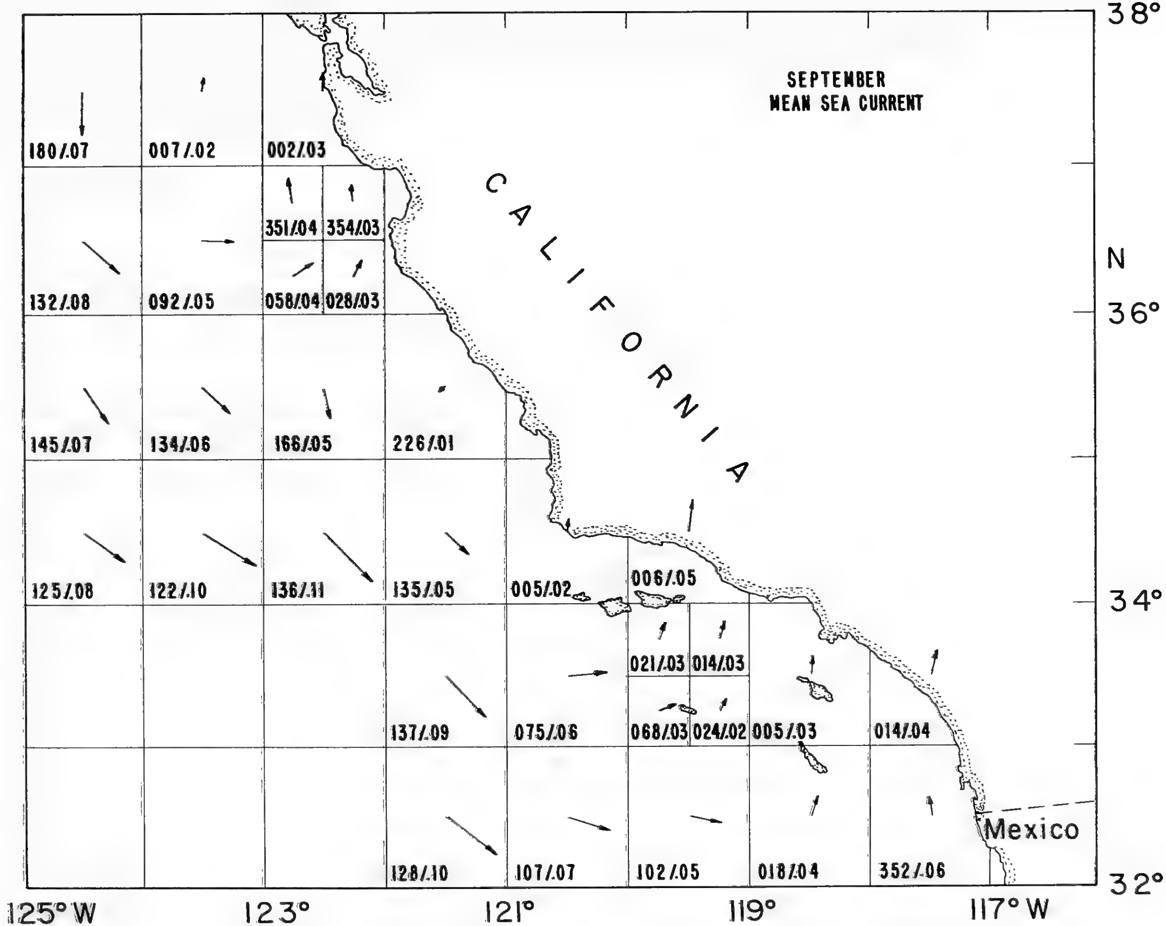


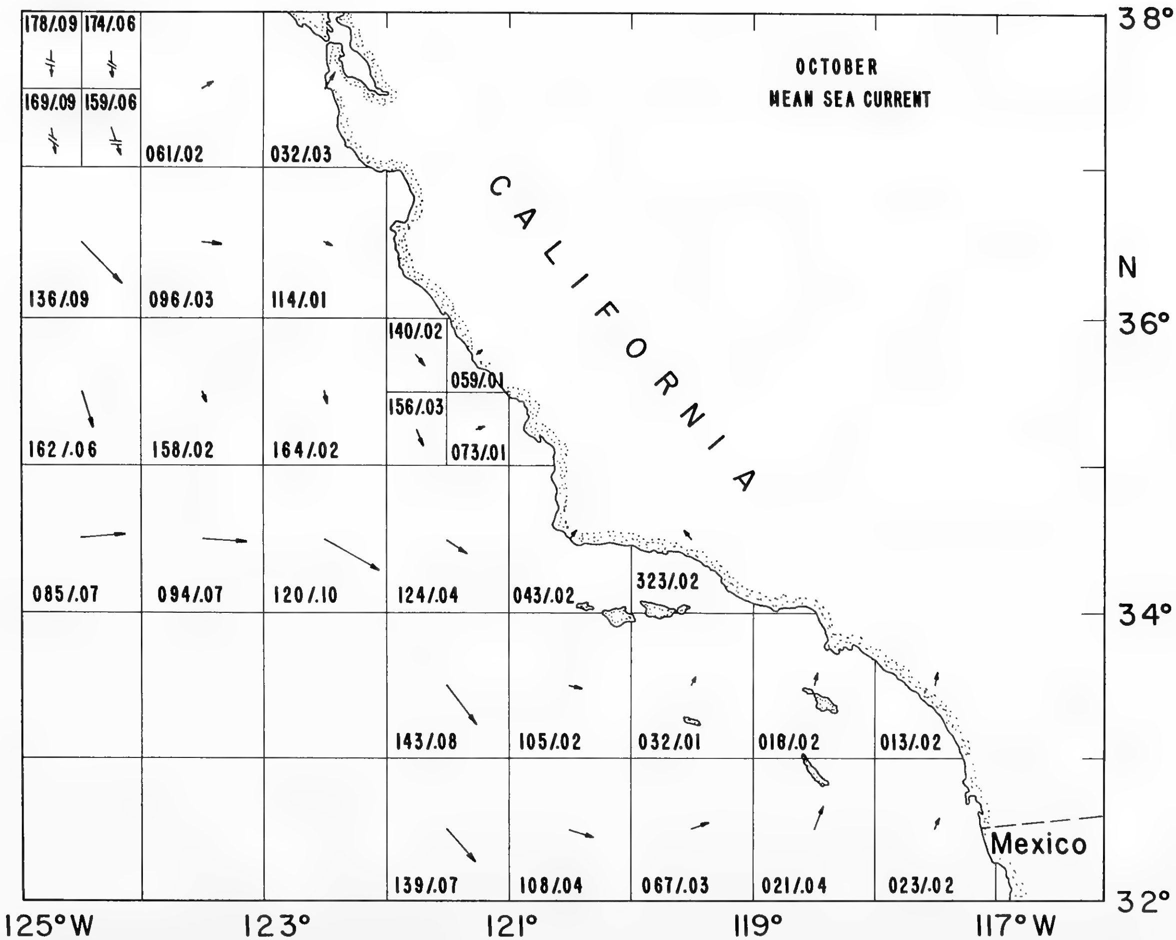
MAY
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
36°
34°
32°
N
125°W
123°
121°
119°
117°W
176/.10
173/.09
178/.05
141/.08
144/.11
149/.13
132/.10
147/.12
150/.13
138/.08
132/.05
136/.05
141/.01
149/.04
150/.11
140/.10
118/.08
119/.08
109/.06
115/.04
069/.02
119/.11
129/.11
136/.03
133/.02
125/.16
126/.06
118/.11
113/.13
116/.11
022/.02
029/.02
120/.10
111/.13
122/.11
118/.14
105/.05
074/.04
120/.07
125/.08
114/.05
106/.08
105/.09
147/.11
095/.04
050/.02

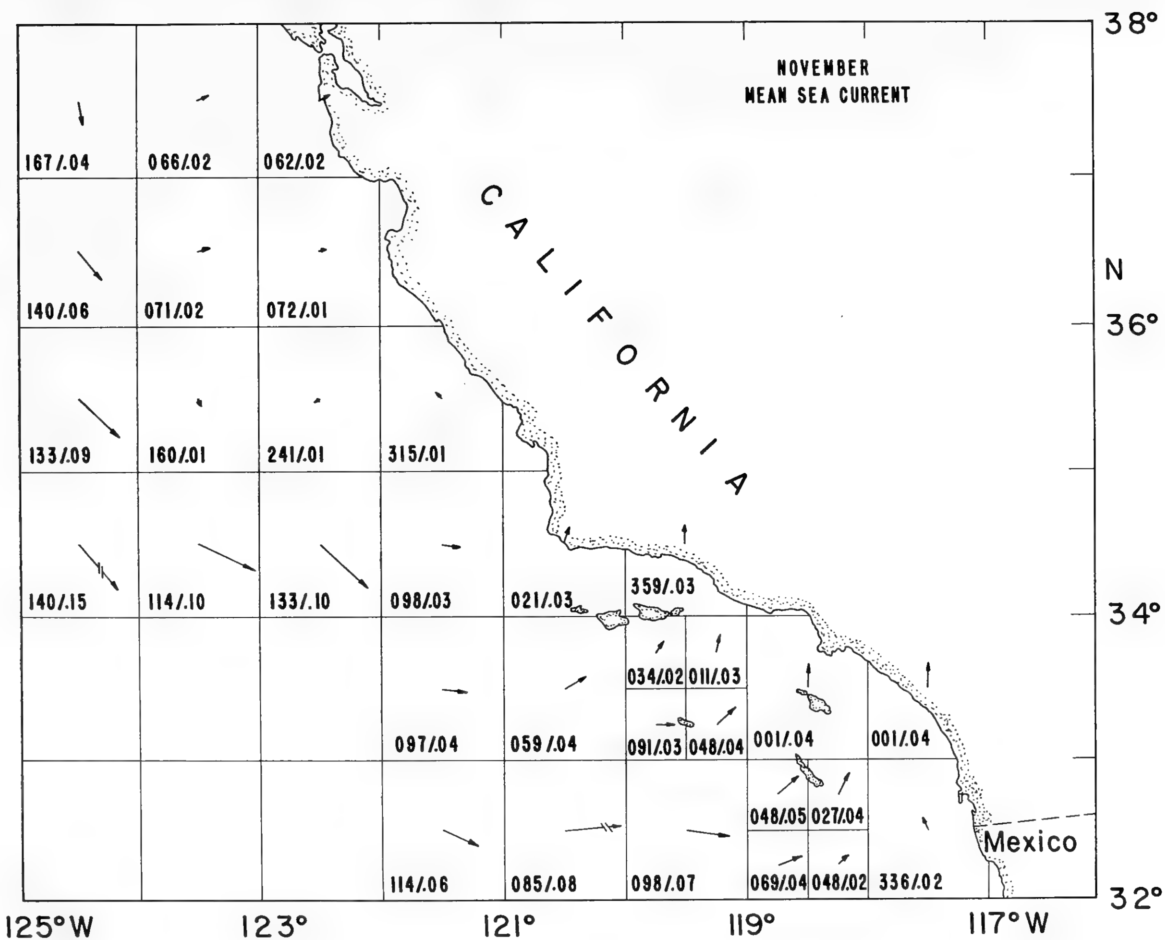

JUNE
MEAN SEA CURRENT
CALIFORNIA
Mexico
N
38°
36°
34°
32°
125°W
123°
121°
119°
117°W
182/.15
203/.03
.00
142/.13
115/.09
121/.07
144/.13
129/.09
145/.06
166/.03
134/.07
159/.10
154/.05
161/.04
137/.01
132/.07
158/.13
126/.08
124/.08
109/.07
114/.04
022/.01
146/.07
145/.06
113/.10
128/.07
037/.02
019/.02
129/.13
145/.11
083/.02
034/.02
013/.02
114/.20
119/.22
116/.09
118/.12
133/.11
126/.13
125/.04
133/.05
148/.07
147/.08
158/.10
099/.03
030/.02

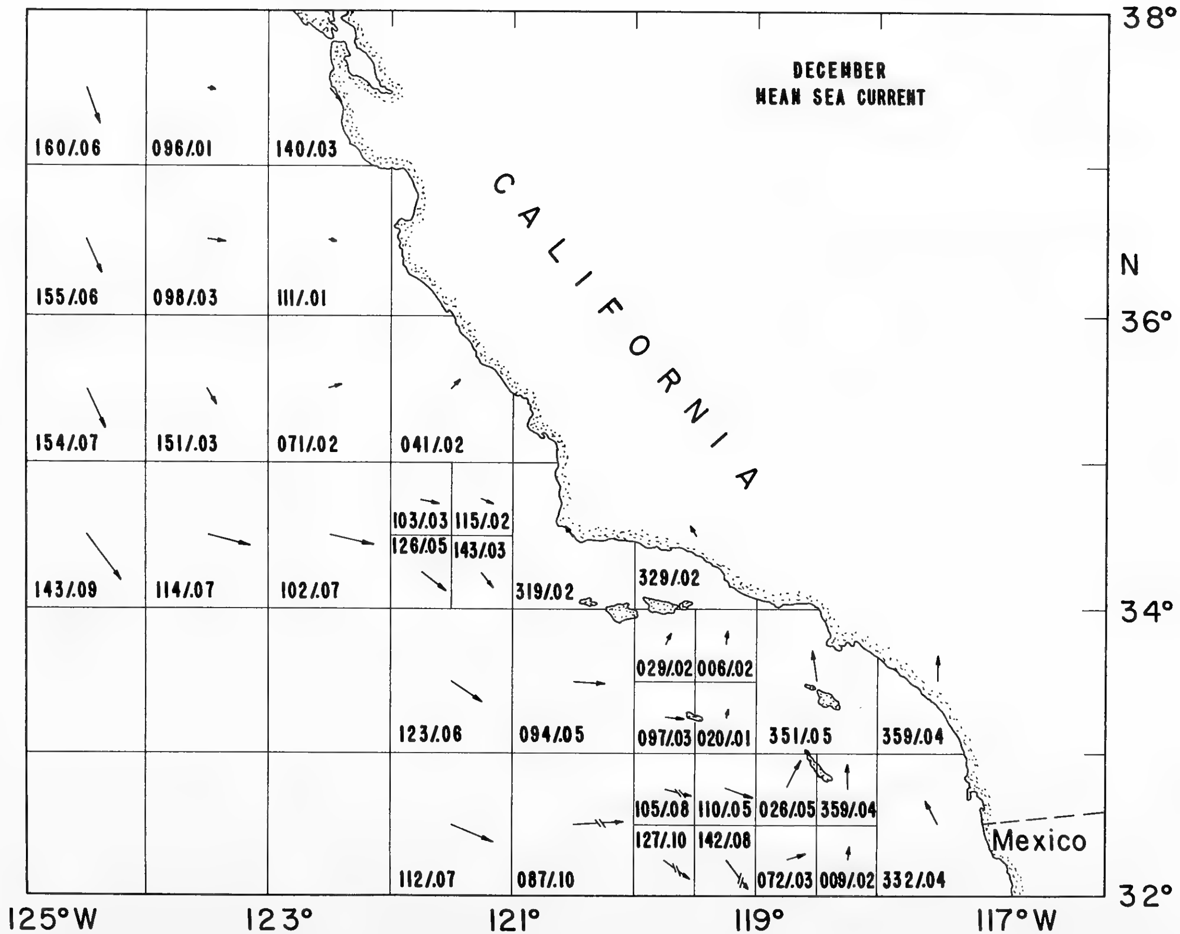

JULY
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
36°
34°
32°
N
125°W
123°
121°
119°
117°W
154/.06
146/.05
168/.02
130/.04
125/.11
135/.07
118/.11
125/.09
138/.13
150/.11
167/.04
162/.02
126/.08
154/.10
164/.09
168/.05
152/.02
079/.01
158/.07
144/.09
138/.10
139/.06
120/.02
195/.01
347/.03
121/.10
156/.06
046/.01
026/.01
114/.15
136/.18
159/.15
123/.03
295/.01
357/.02
011/.02
108/.09
141/.12
122/.09
023/.03
019/.02


AUGUST
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
N
36°
34°
32°
125°W
123°
121°
119°
117°W
190/.14
103/.01
052/.03
148/.08
082/.04
125/.03
172/.04
137/.06
094/.06
094/.04
100/.08
108/.08
110/.07
123/.04
343/.02
321/.04
099/.03
.00
130/.08
159/.05
137/.09
330/.05
336/.03
004/.04
079/.04
053/.03
125/.10
139/.10
098/.04
082/.03
010/.05
347/.03

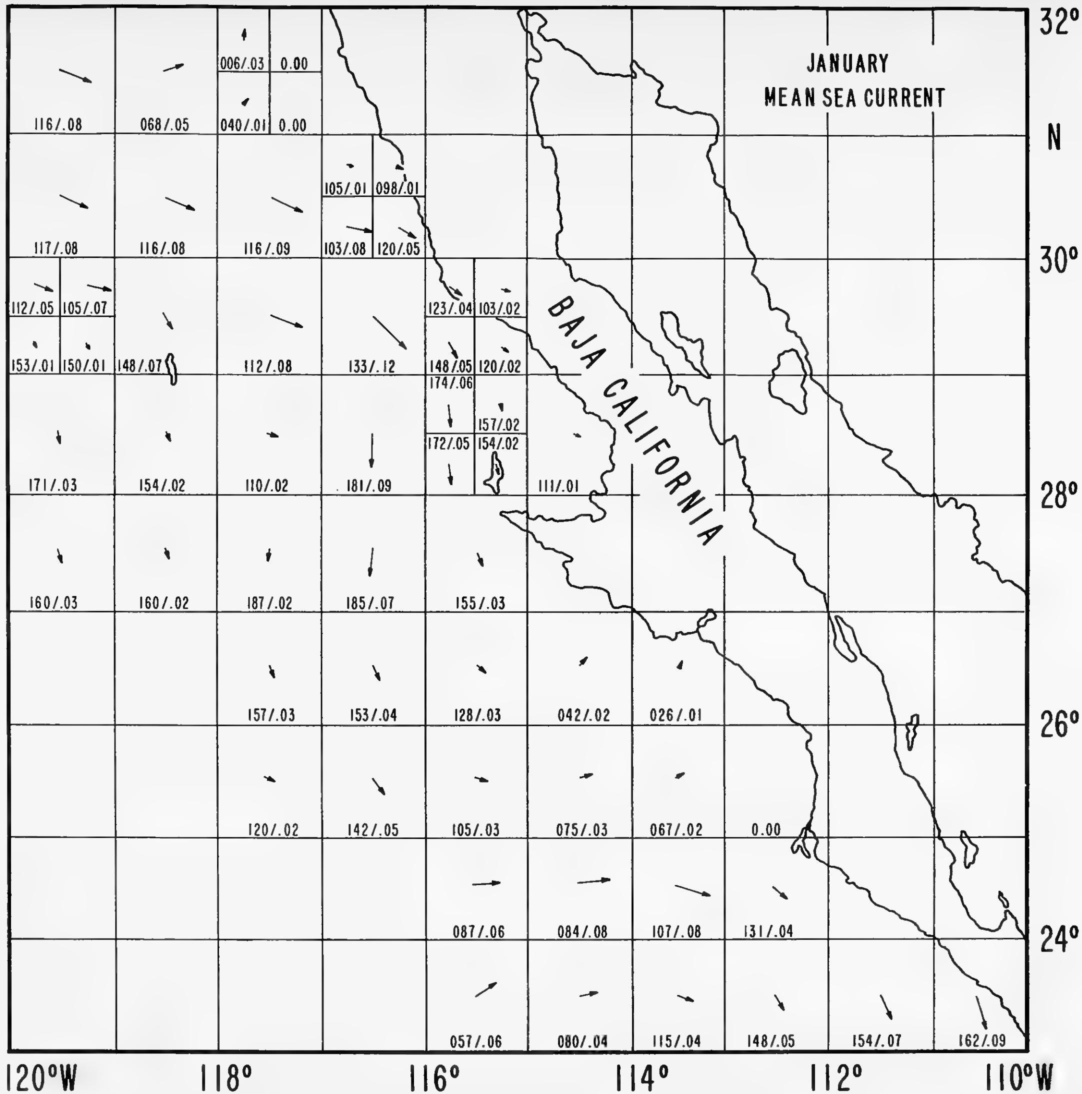

SEPTEMBER
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
N
36°
34°
32°
125° W
123°
121°
119°
117° W
180/.07
007/.02
002/.03
351/04
354/03
132/.08
092/.05
058/04
028/03
145/.07
134/.06
166/.05
226/.01
125/.08
122/.10
136/.11
135/.05
005/.02
006/.05
021/.03
014/.03
137/.09
075/.06
068/.03
024/.02
005/.03
014/.04
128/.10
107/.07
102/.05
018/.04
352/.06

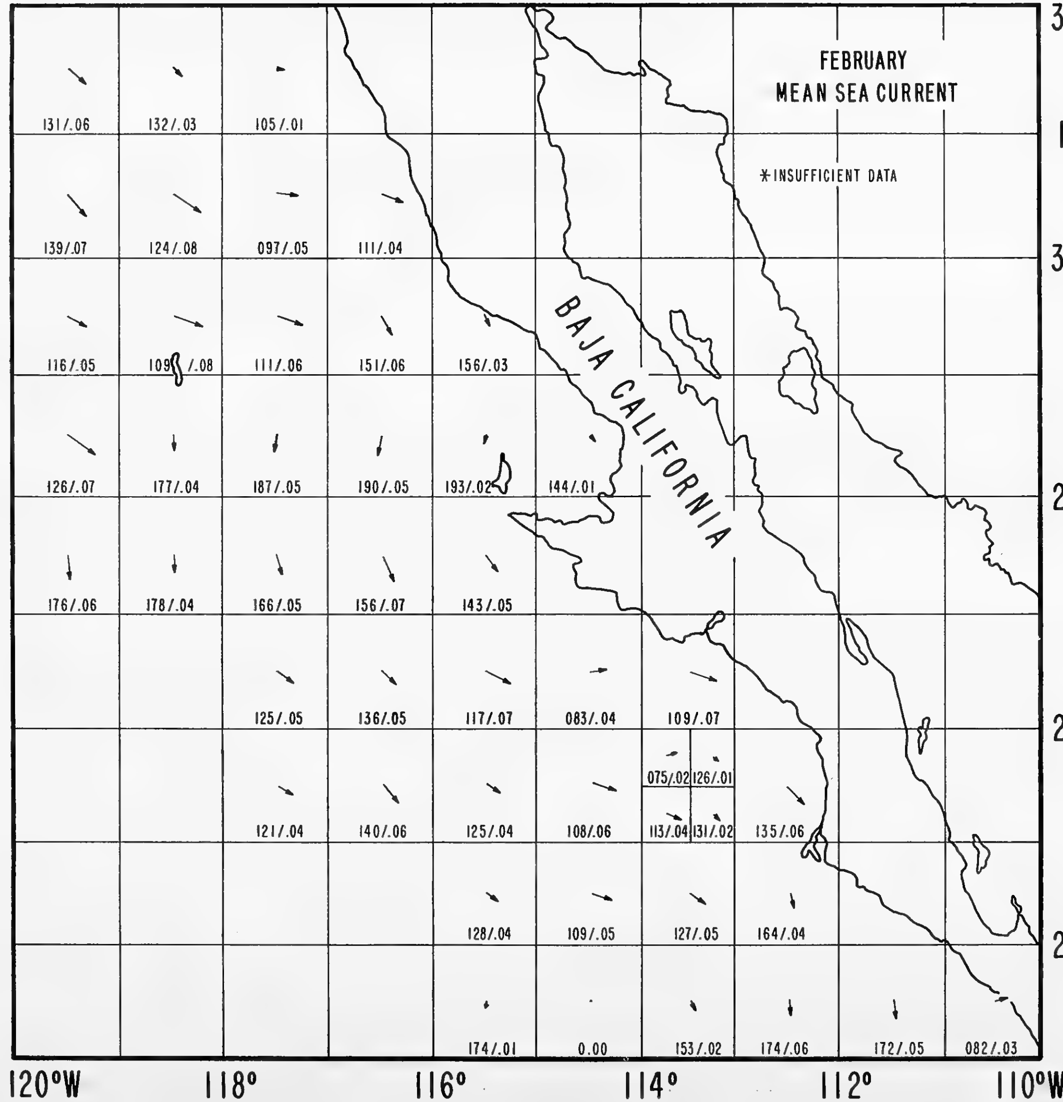

OCTOBER
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
N
36°
34°
32°
125°W
123°
121°
119°
117°W
178/.09
174/.06
169/.09
159/.06
061/.02
032/.03
136/.09
096/.03
114/.01
140/.02
059/.01
156/.03
073/.01
162/.06
158/.02
164/.02
085/.07
094/.07
120/.10
124/.04
043/.02
323/.02
143/.08
105/.02
032/.01
018/.02
013/.02
139/.07
108/.04
067/.03
021/.04
023/.02


NOVEMBER
MEAN SEA CURRENT
CALIFORNIA
Mexico
N
38°
36°
34°
32°
125°W
123°
121°
119°
117°W
167/.04
066/.02
062/.02
140/.06
071/.02
072/.01
133/.09
160/.01
241/.01
315/.01
140/.15
114/.10
133/.10
098/.03
021/.03
359/.03
034/.02
011/.03
097/.04
059/.04
091/.03
048/.04
001/.04
001/.04
048/.05
027/.04
114/.06
085/.08
098/.07
069/.04
048/.02
336/.02

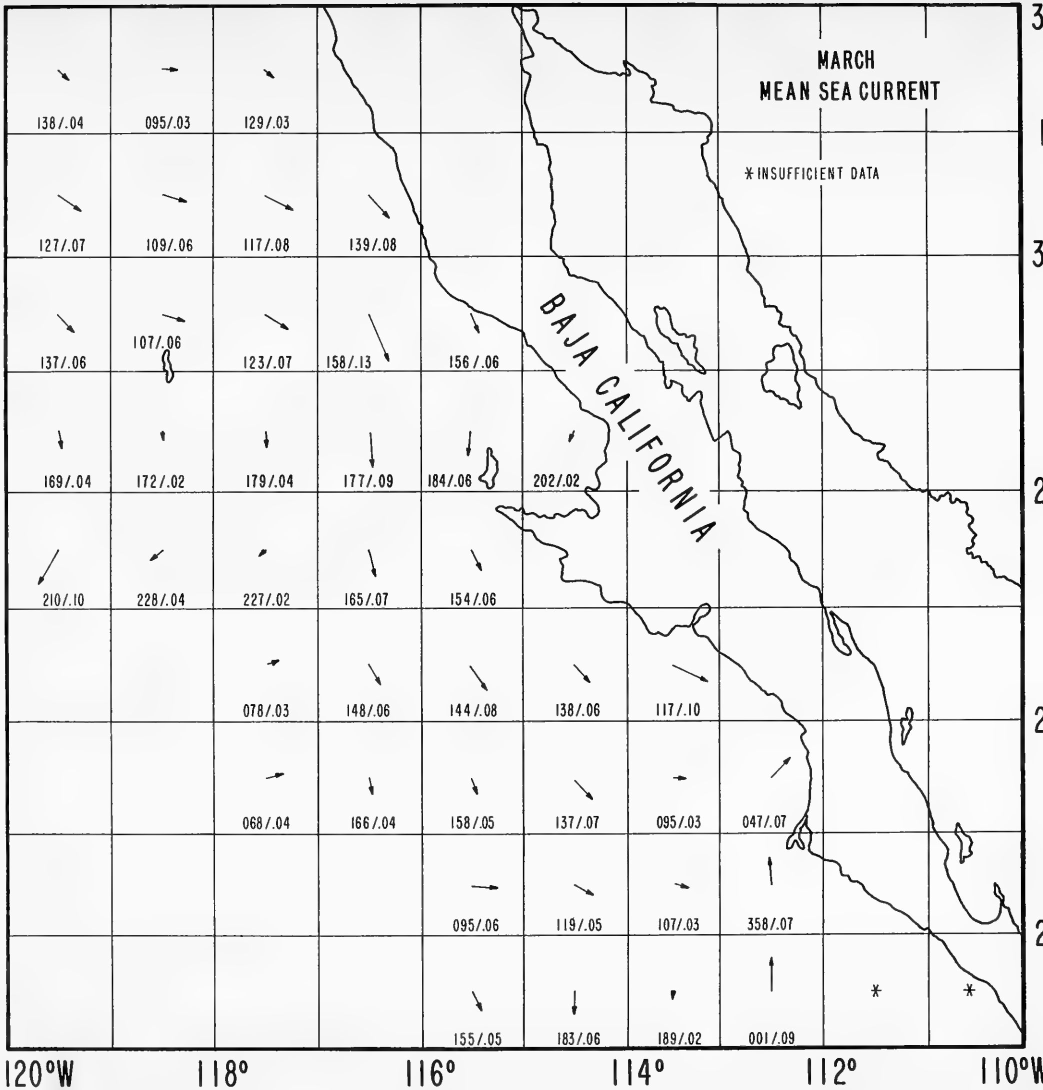


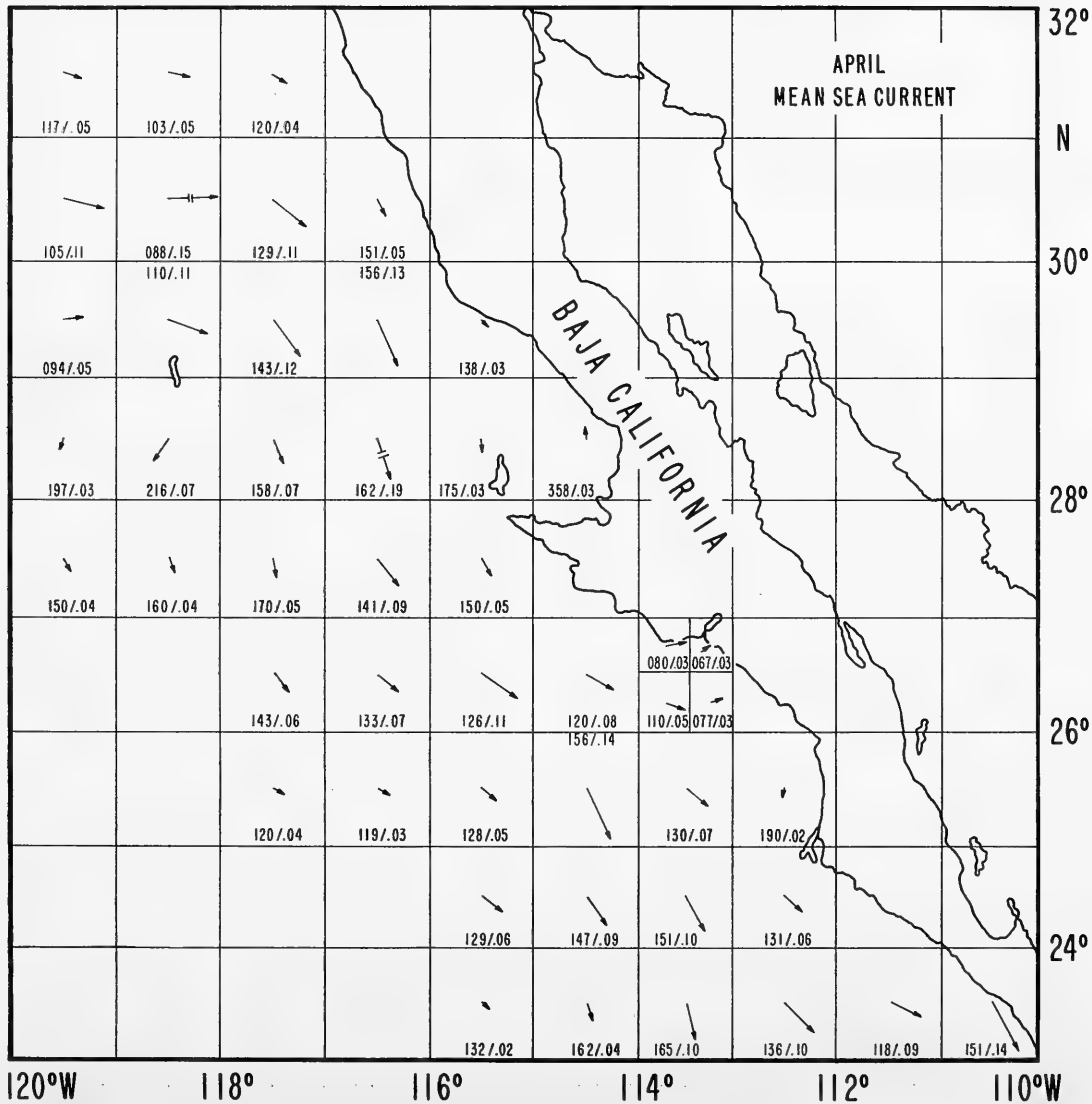
DECEMBER
MEAN SEA CURRENT
CALIFORNIA
Mexico
38°
N
36°
34°
32°
125°W
123°
121°
119°
117°W
160/.06
096/.01
140/.03
155/.06
098/.03
111/.01
154/.07
151/.03
071/.02
041/.02
103/.03
115/.02
126/.05
143/.03
143/.09
114/.07
102/.07
319/.02
329/.02
029/.02
006/.02
123/.06
094/.05
097/.03
020/.01
351/.05
359/.04
105/.08
110/.05
026/.05
359/.04
127/.10
142/.08
112/.07
087/.10
072/.03
009/.02
332/.04

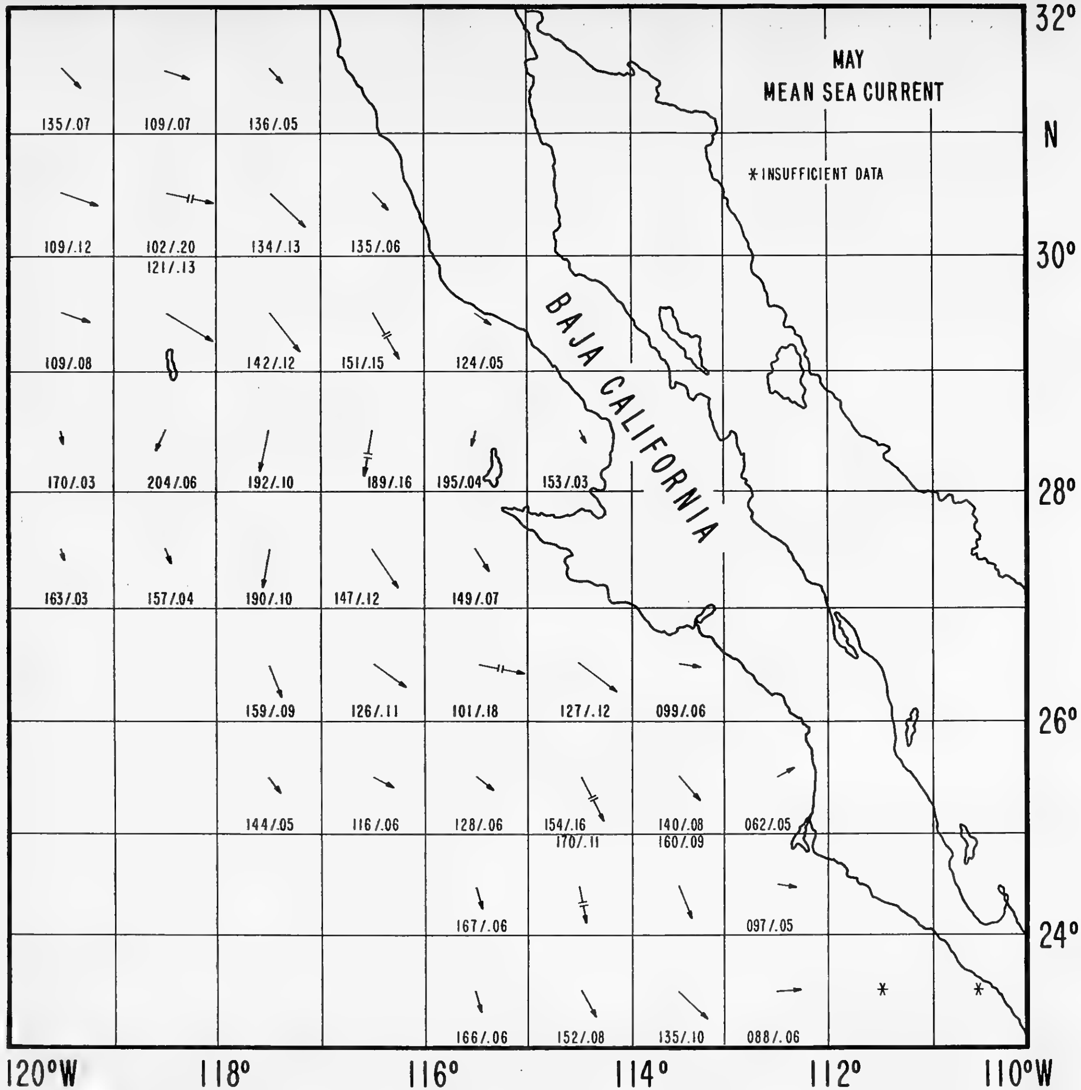

JANUARY
MEAN SEA CURRENT
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
116/.08
068/.05
006/.03
0.00
040/.01
0.00
105/.01
098/.01
117/.08
116/.08
116/.09
103/.08
120/.05
112/.05
105/.07
123/.04
103/.02
153/.01
150/.01
148/.07
112/.08
133/.12
148/.05
120/.02
174/.06
157/.02
172/.05
154/.02
171/.03
154/.02
110/.02
181/.09
111/.01
160/.03
160/.02
187/.02
185/.07
155/.03
157/.03
153/.04
128/.03
042/.02
026/.01
120/.02
142/.05
105/.03
075/.03
067/.02
0.00
087/.06
084/.08
107/.08
131/.04
057/.06
080/.04
115/.04
148/.05
154/.07
162/.09

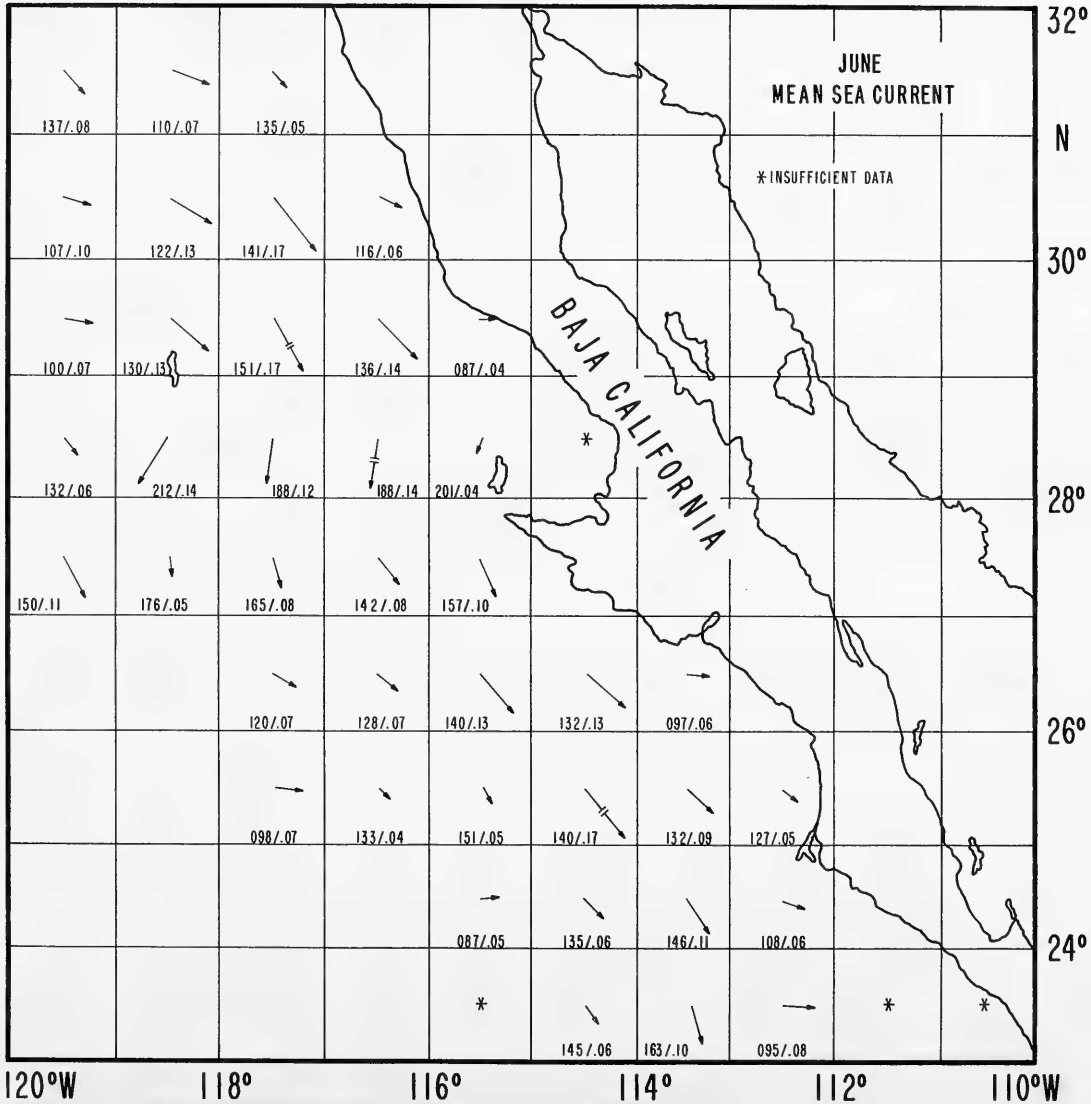


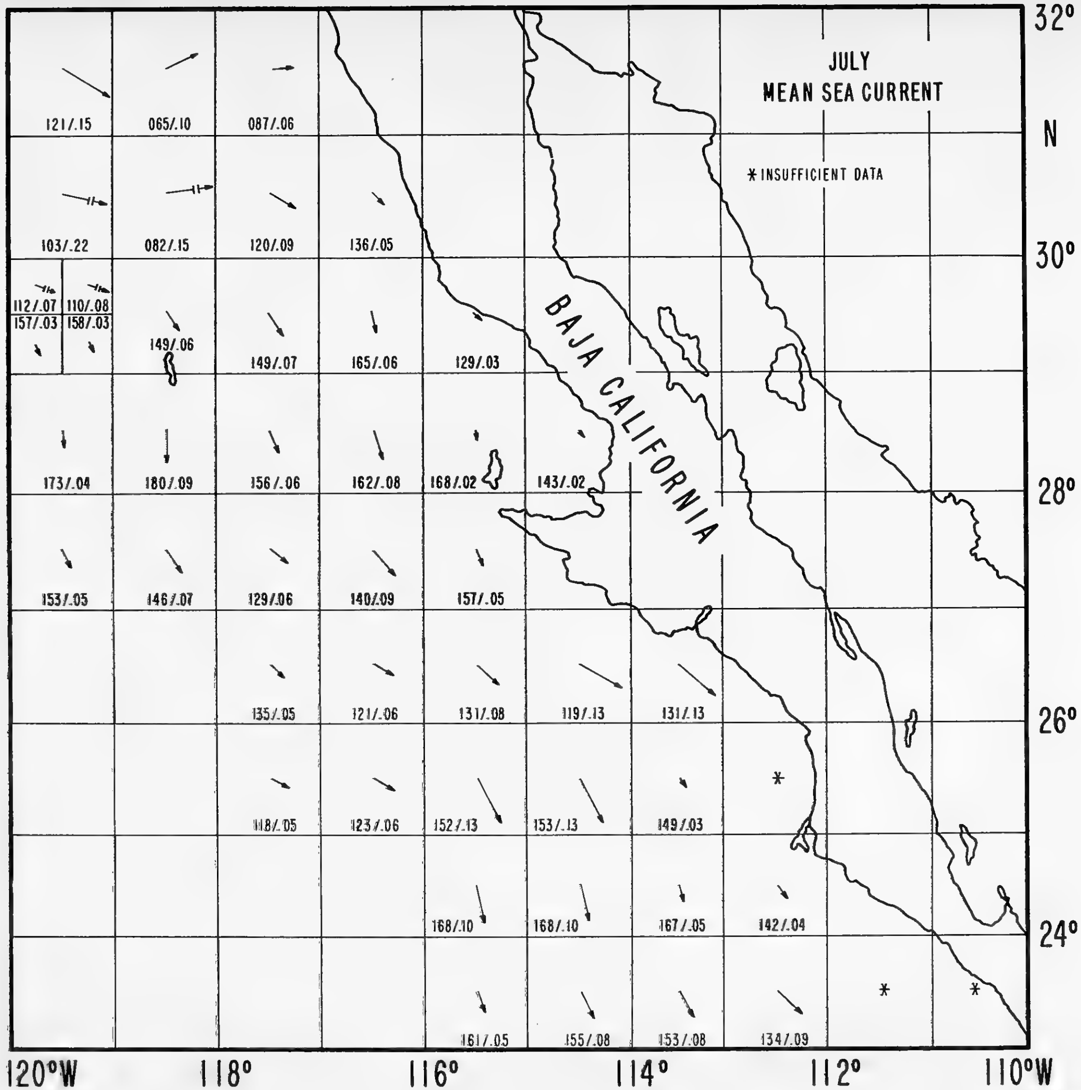
FEBRUARY
MEAN SEA CURRENT
N
*INSUFFICIENT DATA
BAJA CALIFORNIA
131/.06
132/.03
105/.01
139/.07
124/.08
097/.05
111/.04
116/.05
109/.08
111/.06
151/.06
156/.03
126/.07
177/.04
187/.05
190/.05
193/.02
144/.01
176/.06
178/.04
166/.05
156/.07
143/.05
125/.05
136/.05
117/.07
083/.04
109/.07
075/.02
126/.01
121/.04
140/.06
125/.04
108/.06
113/.04
131/.02
135/.06
128/.04
109/.05
127/.05
164/.04
174/.01
0.00
153/.02
174/.06
172/.05
082/.03
32°
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W

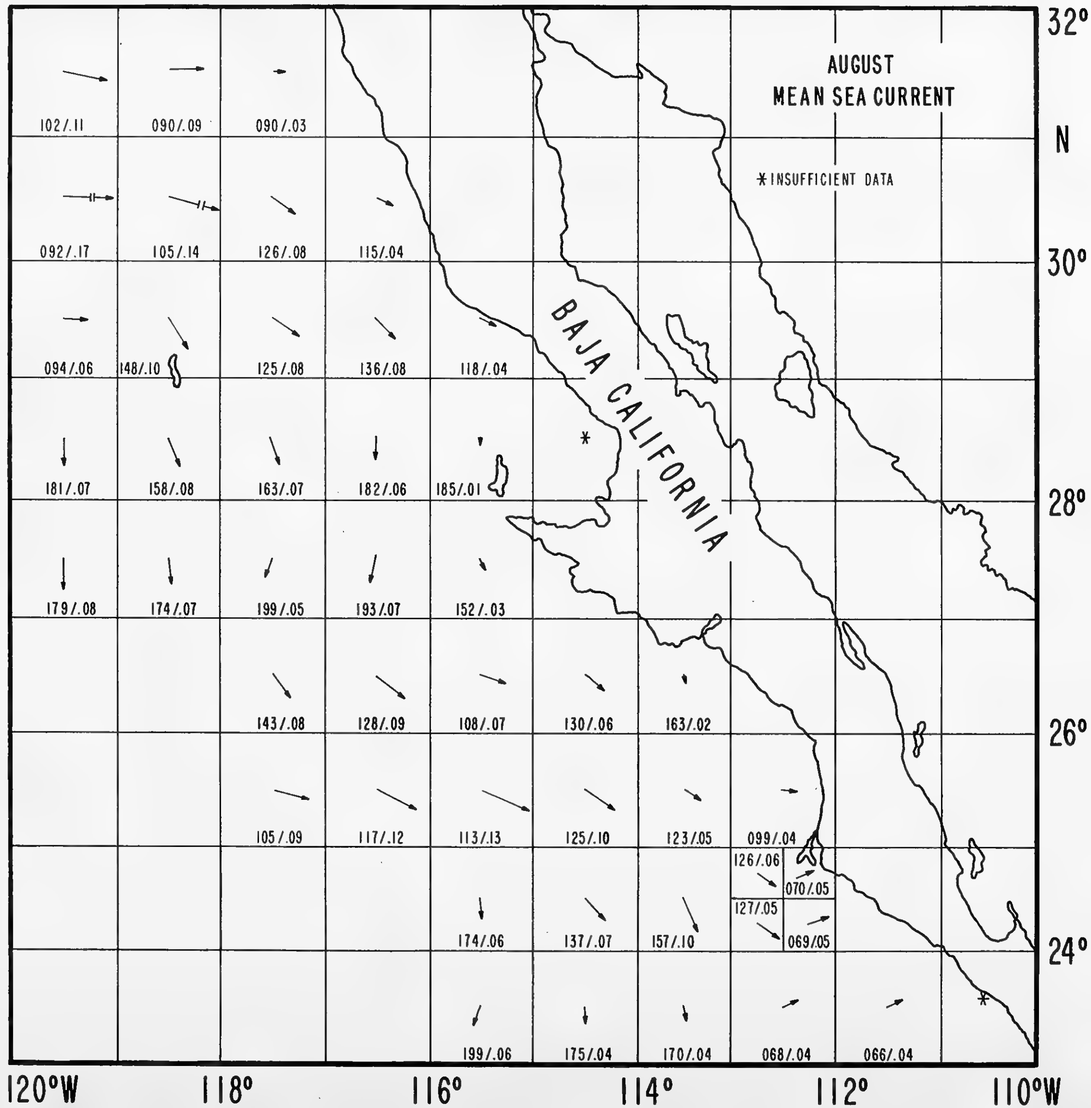

MARCH
MEAN SEA CURRENT
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
138/.04
095/.03
129/.03
127/.07
109/.06
117/.08
139/.08
137/.06
107/.06
123/.07
158/.13
156/.06
169/.04
172/.02
179/.04
177/.09
184/.06
202/.02
210/.10
228/.04
227/.02
165/.07
154/.06
078/.03
148/.06
144/.08
138/.06
117/.10
068/.04
166/.04
158/.05
137/.07
095/.03
047/.07
095/.06
119/.05
107/.03
358/.07
155/.05
183/.06
189/.02
001/.09
*
*

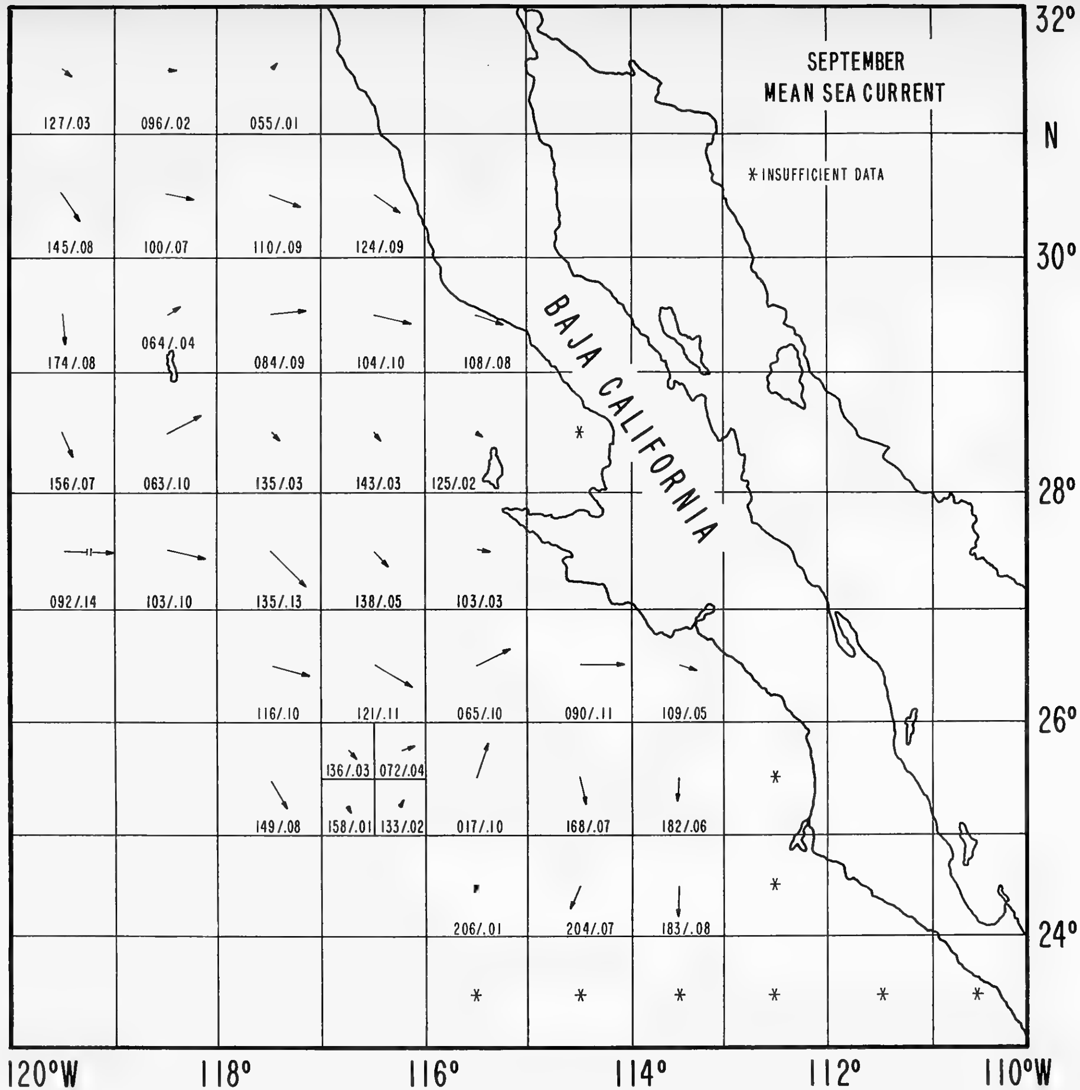

APRIL
MEAN SEA CURRENT
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
117/.05
103/.05
120/.04
105/.11
088/.15
110/.11
129/.11
151/.05
156/.13
094/.05
143/.12
138/.03
197/.03
216/.07
158/.07
162/.19
175/.03
358/.03
150/.04
160/.04
170/.05
141/.09
150/.05
080/.03
067/.03
143/.06
133/.07
126/.11
120/.08
156/.14
110/.05
077/.03
120/.04
119/.03
128/.05
130/.07
190/.02
129/.06
147/.09
151/.10
131/.06
132/.02
162/.04
165/.10
136/.10
118/.09
151/.14

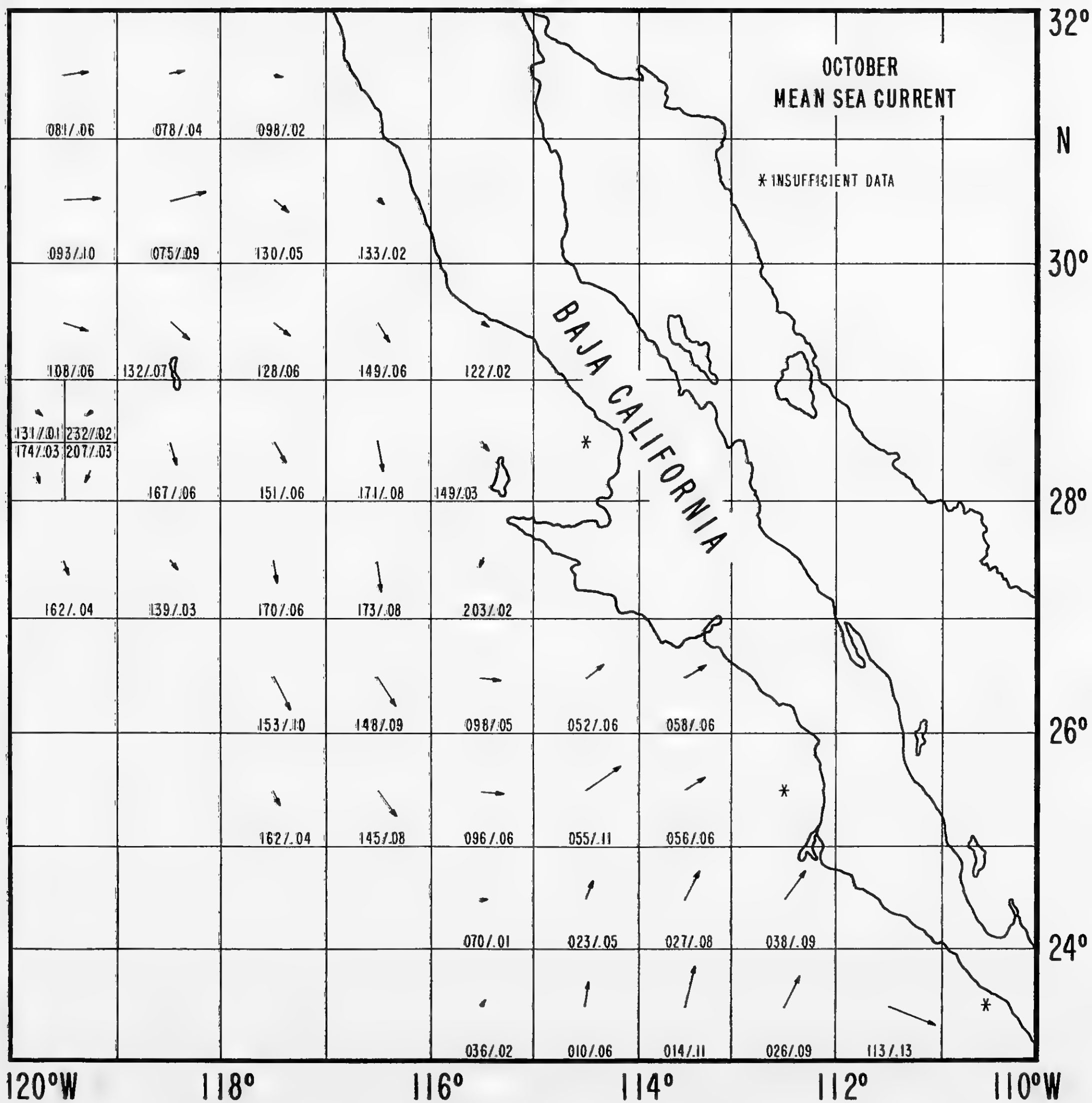

MAY
MEAN SEA CURRENT
N
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
135/.07
109/.07
136/.05
109/.12
102/.20
121/.13
134/.13
135/.06
109/.08
142/.12
151/.15
124/.05
170/.03
204/.06
192/.10
189/.16
195/.04
153/.03
163/.03
157/.04
190/.10
147/.12
149/.07
159/.09
126/.11
101/.18
127/.12
099/.06
144/.05
116/.06
128/.06
154/.16
170/.11
140/.08
160/.09
062/.05
167/.06
097/.05
166/.06
152/.08
135/.10
088/.06

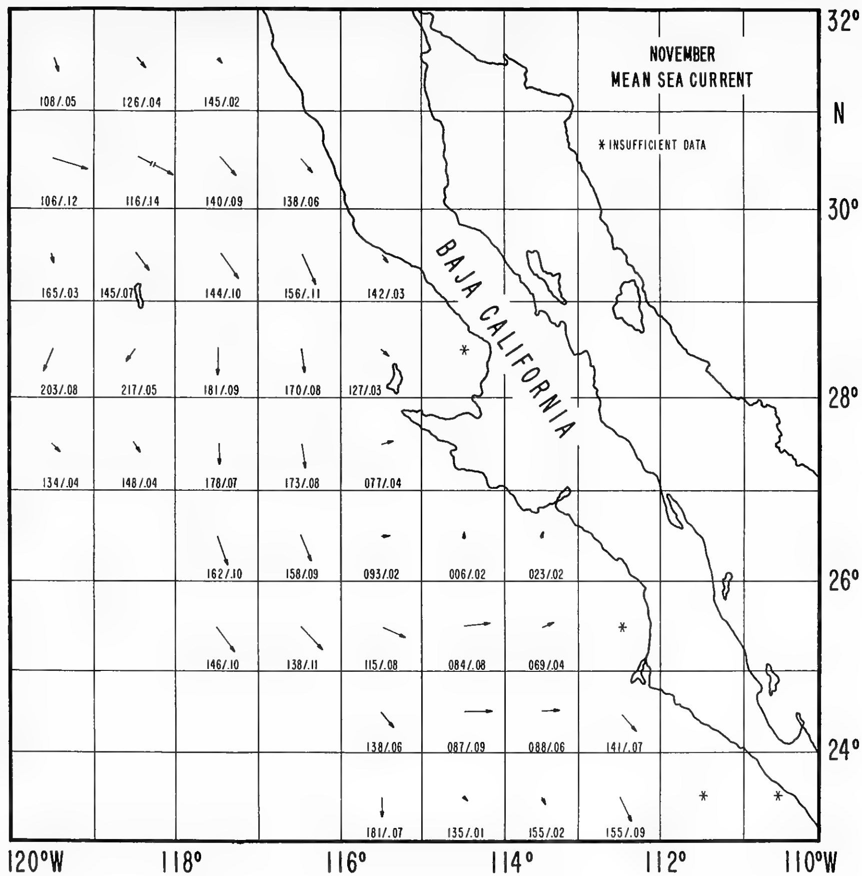

JUNE
MEAN SEA CURRENT
N
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
137/.08
110/.07
135/.05
107/.10
122/.13
141/.17
116/.06
100/.07
130/.13
151/.17
136/.14
087/.04
132/.06
212/.14
188/.12
188/.14
201/.04
150/.11
176/.05
165/.08
142/.08
157/.10
120/.07
128/.07
140/.13
132/.13
097/.06
098/.07
133/.04
151/.05
140/.17
132/.09
127/.05
087/.05
135/.06
146/.11
108/.06
145/.06
163/.10
095/.08

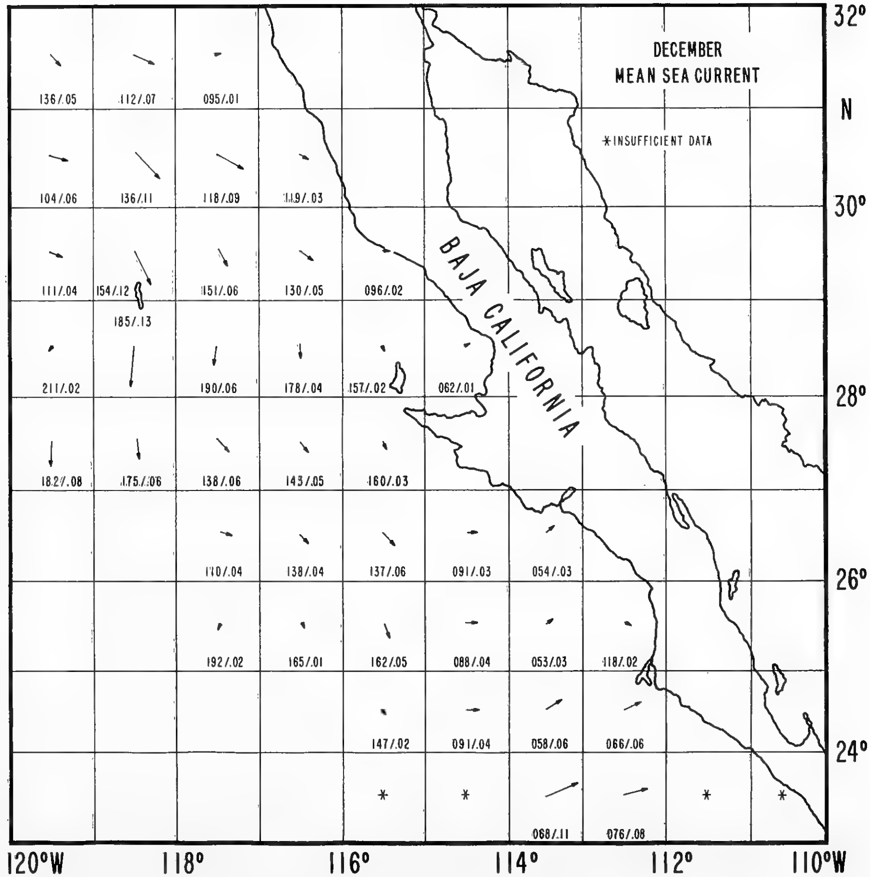

JULY
MEAN SEA CURRENT
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
121/.15
065/.10
087/.06
103/.22
082/.15
120/.09
136/.05
112/.07
110/.08
157/.03
158/.03
149/.06
149/.07
165/.06
129/.03
173/.04
180/.09
156/.06
162/.08
168/.02
143/.02
153/.05
146/.07
129/.06
140/.09
157/.05
135/.05
121/.06
131/.08
119/.13
131/.13
118/.05
123/.06
152/.13
153/.13
149/.03
*
168/.10
168/.10
167/.05
142/.04
161/.05
155/.08
153/.08
134/.09
*
*


AUGUST
MEAN SEA CURRENT
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
102/.11
090/.09
090/.03
092/.17
105/.14
126/.08
115/.04
094/.06
148/.10
125/.08
136/.08
118/.04
181/.07
158/.08
163/.07
182/.06
185/.01
179/.08
174/.07
199/.05
193/.07
152/.03
143/.08
128/.09
108/.07
130/.06
163/.02
105/.09
117/.12
113/.13
125/.10
123/.05
099/.04
126/.06
070/.05
127/.05
069/.05
174/.06
137/.07
157/.10
199/.06
175/.04
170/.04
068/.04
066/.04

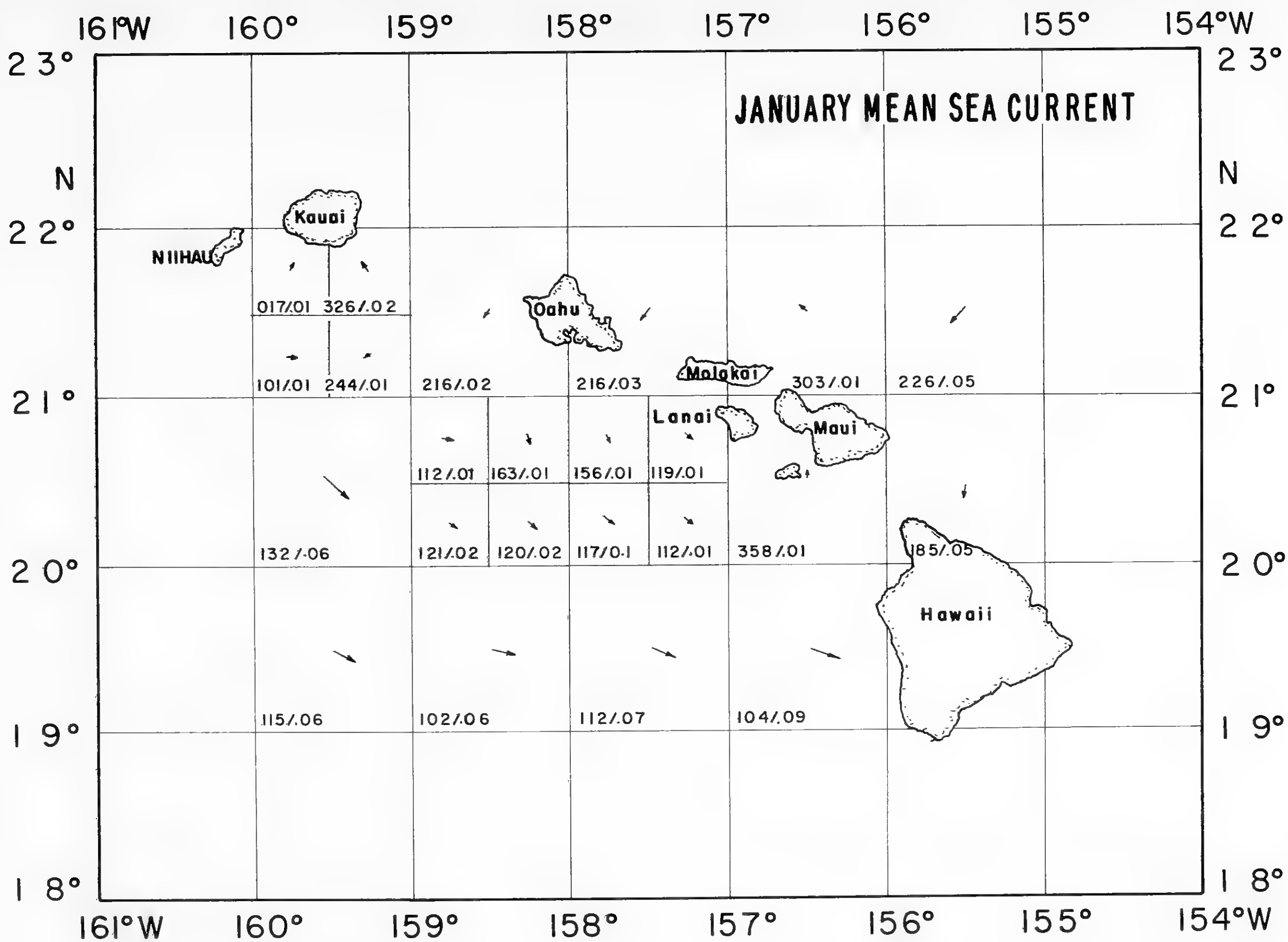

SEPTEMBER
MEAN SEA CURRENT
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
127/.03
096/.02
055/.01
145/.08
100/.07
110/.09
124/.09
174/.08
064/.04
084/.09
104/.10
108/.08
156/.07
063/.10
135/.03
143/.03
125/.02
092/.14
103/.10
135/.13
138/.05
103/.03
116/.10
121/.11
065/.10
090/.11
109/.05
136/.03
072/.04
149/.08
158/.01
133/.02
017/.10
168/.07
182/.06
206/.01
204/.07
183/.08


OCTOBER
MEAN SEA CURRENT
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
081/.06
078/.04
098/.02
093/.10
075/.09
130/.05
133/.02
108/.06
132/.07
128/.06
149/.06
122/.02
131/.01
232/.02
174/.03
207/.03
167/.06
151/.06
171/.08
149/.03
162/.04
139/.03
170/.06
173/.08
203/.02
153/.10
148/.09
098/.05
052/.06
058/.06
162/.04
145/.08
096/.06
055/.11
056/.06
070/.01
023/.05
027/.08
038/.09
036/.02
010/.06
014/.11
026/.09
113/.13

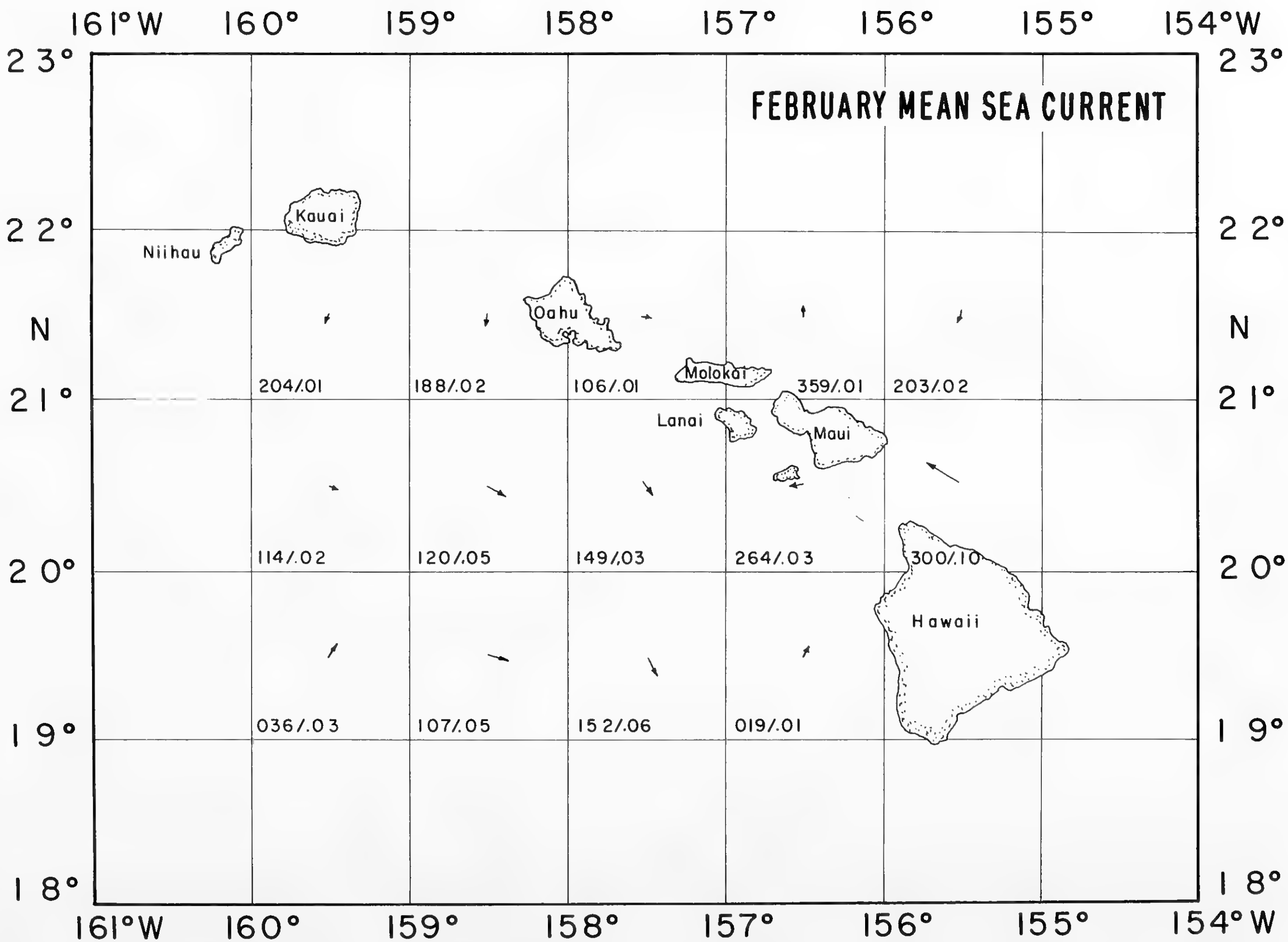

NOVEMBER
MEAN SEA CURRENT
* INSUFFICIENT DATA
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
108/.05
126/.04
145/.02
106/.12
116/.14
140/.09
138/.06
165/.03
145/.07
144/.10
156/.11
142/.03
203/.08
217/.05
181/.09
170/.08
127/.03
134/.04
148/.04
178/.07
173/.08
077/.04
162/.10
158/.09
093/.02
006/.02
023/.02
146/.10
138/.11
115/.08
084/.08
069/.04
138/.06
087/.09
088/.06
141/.07
181/.07
135/.01
155/.02
155/.09

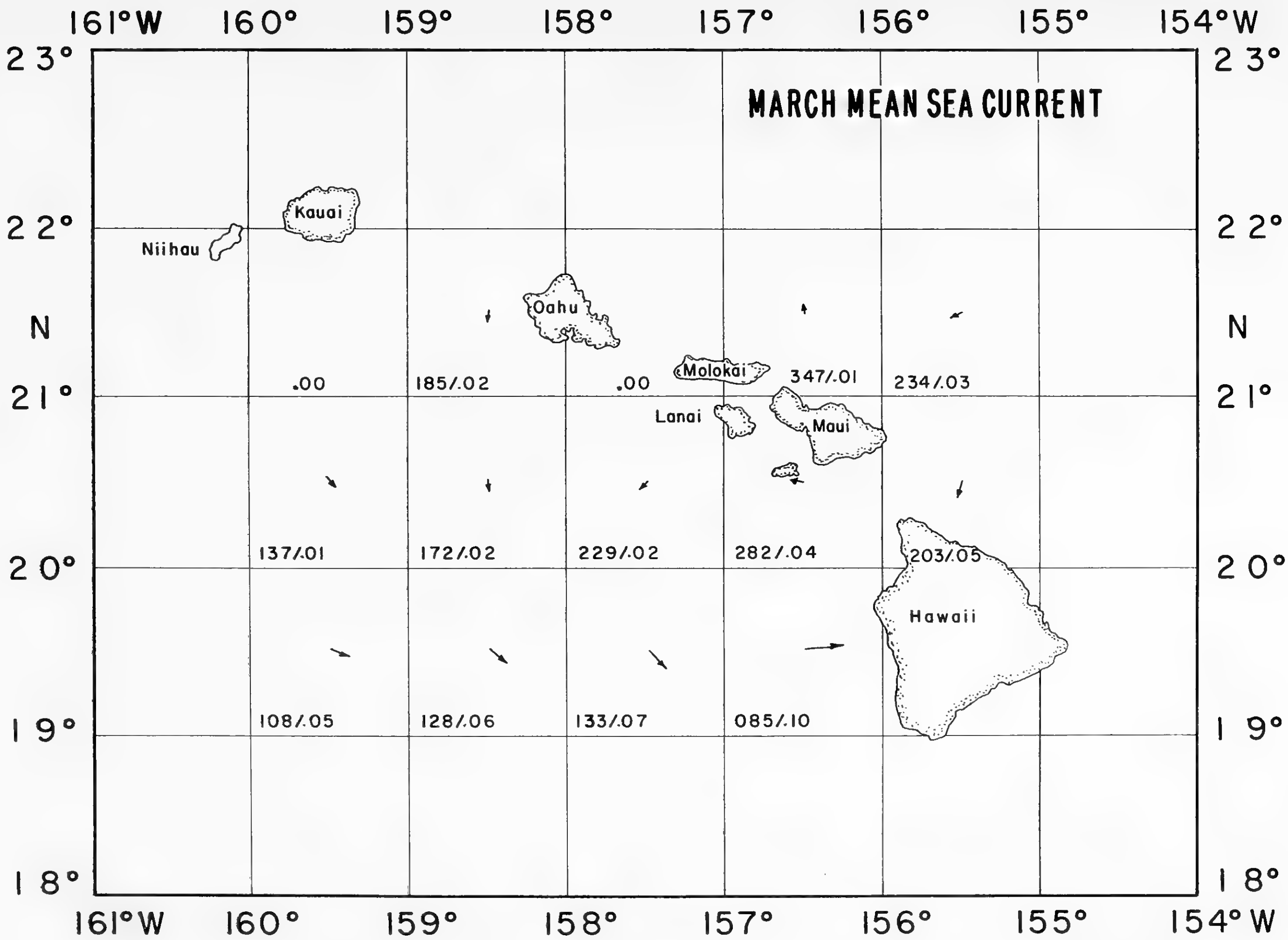


DECEMBER
MEAN SEA CURRENT
*INSUFFICIENT DATA
BAJA CALIFORNIA
32°
N
30°
28°
26°
24°
120°W
118°
116°
114°
112°
110°W
136/.05
112/.07
095/.01
104/.06
136/.11
118/.09
119/.03
111/.04
154/.12
151/.06
130/.05
096/.02
185/.13
211/.02
190/.06
178/.04
157/.02
062/.01
182/.08
175/.06
138/.06
143/.05
160/.03
110/.04
138/.04
137/.06
091/.03
054/.03
192/.02
165/.01
162/.05
088/.04
053/.03
118/.02
147/.02
091/.04
058/.06
066/.06
068/.11
076/.08

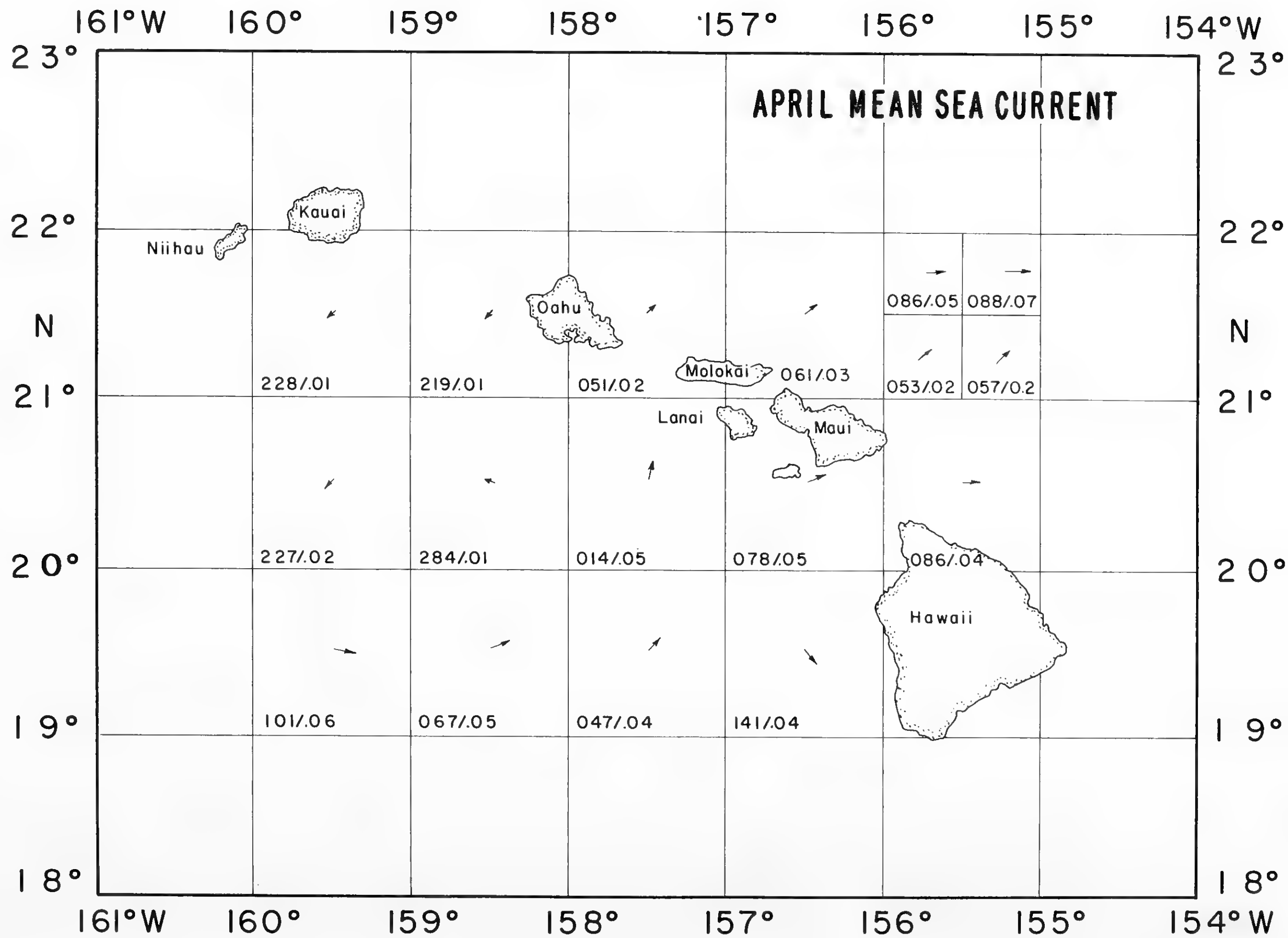


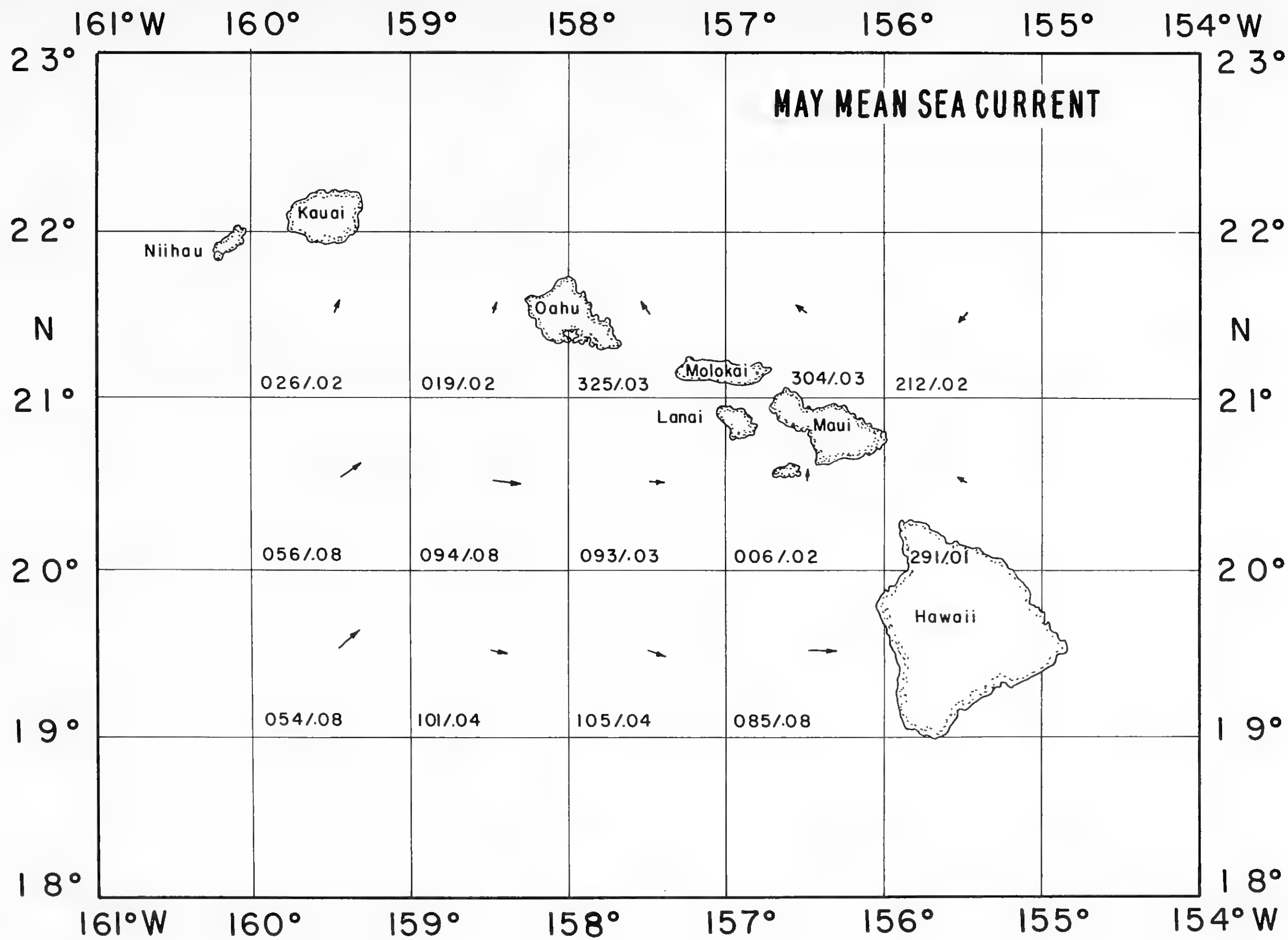
JANUARY MEAN SEA CURRENT
161°W
160°
159°
158°
157°
156°
155°
154°W
23°
N
22°
21°
20°
19°
18°
NIIHAU
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
017/.01
326/.02
101/.01
244/.01
216/.02
216/.03
303/.01
226/.05
112/.01
163/.01
156/.01
119/.01
132/.06
121/.02
120/.02
117/0.1
112/.01
358/.01
185/.05
115/.06
102/.06
112/.07
104/.09

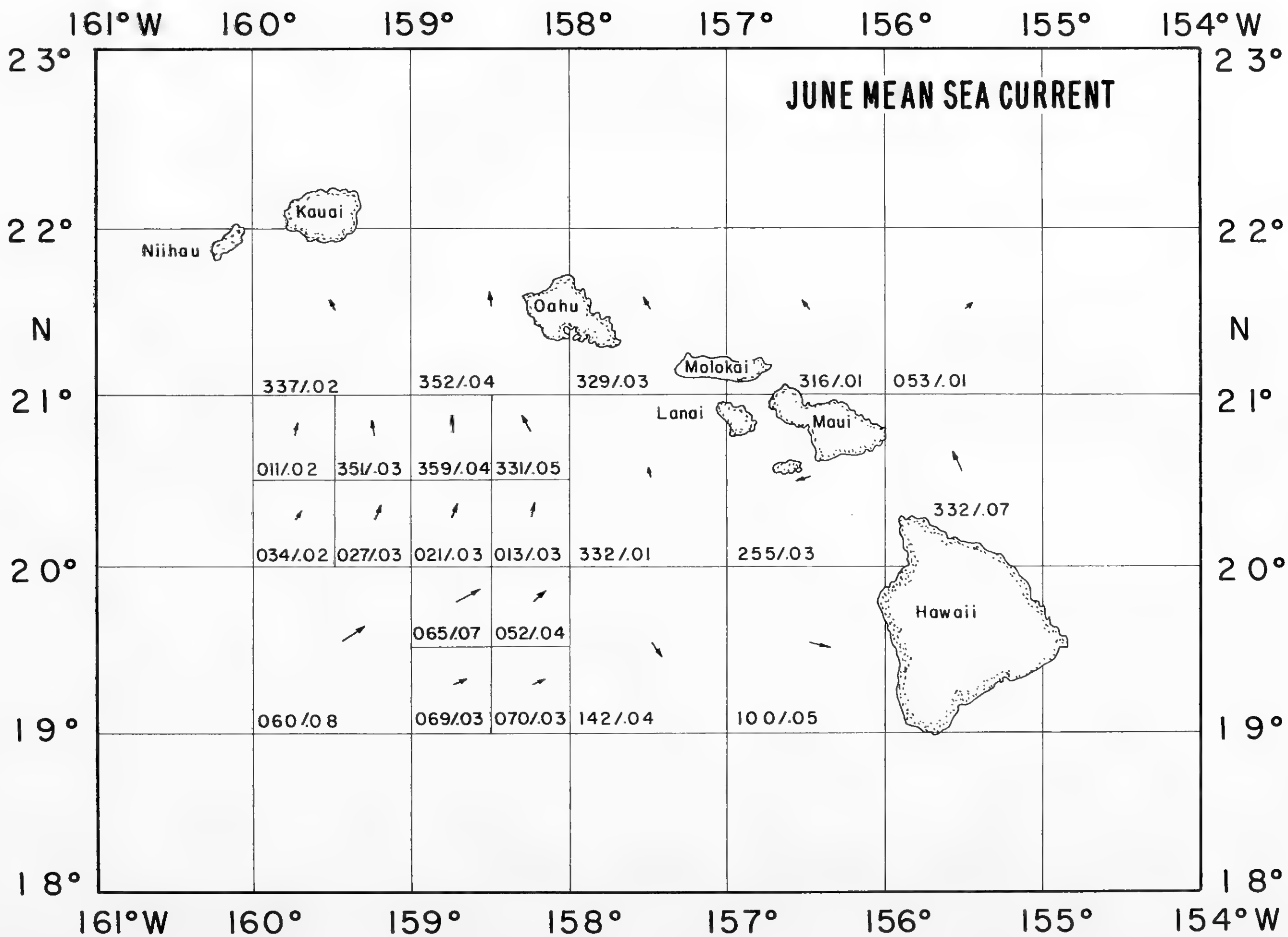

FEBRUARY MEAN SEA CURRENT
161°W
160°
159°
158°
157°
156°
155°
154°W
23°
22°
N
21°
20°
19°
18°
Kauai
Niihau
Oahu
Molokai
Lanai
Maui
Hawaii
204/.01
188/.02
106/.01
359/.01
203/.02
114/.02
120/.05
149/.03
264/.03
300/.10
036/.03
107/.05
152/.06
019/.01

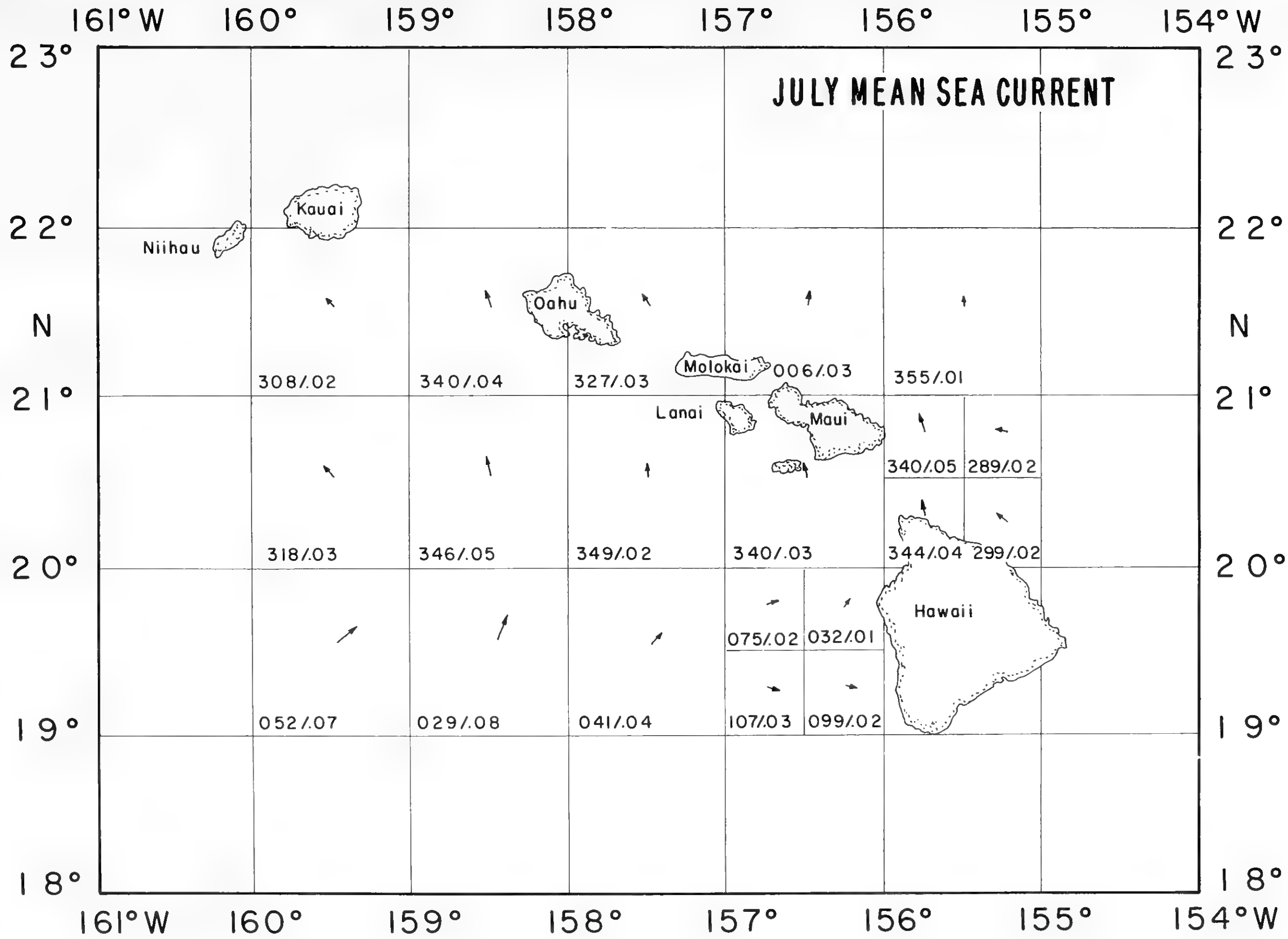


MARCH MEAN SEA CURRENT
161°W
160°
159°
158°
157°
156°
155°
154°W
23°
22°
N
21°
20°
19°
18°
Niihau
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
.00
185/.02
.00
347/.01
234/.03
137/.01
172/.02
229/.02
282/.04
203/.05
108/.05
128/.06
133/.07
085/.10

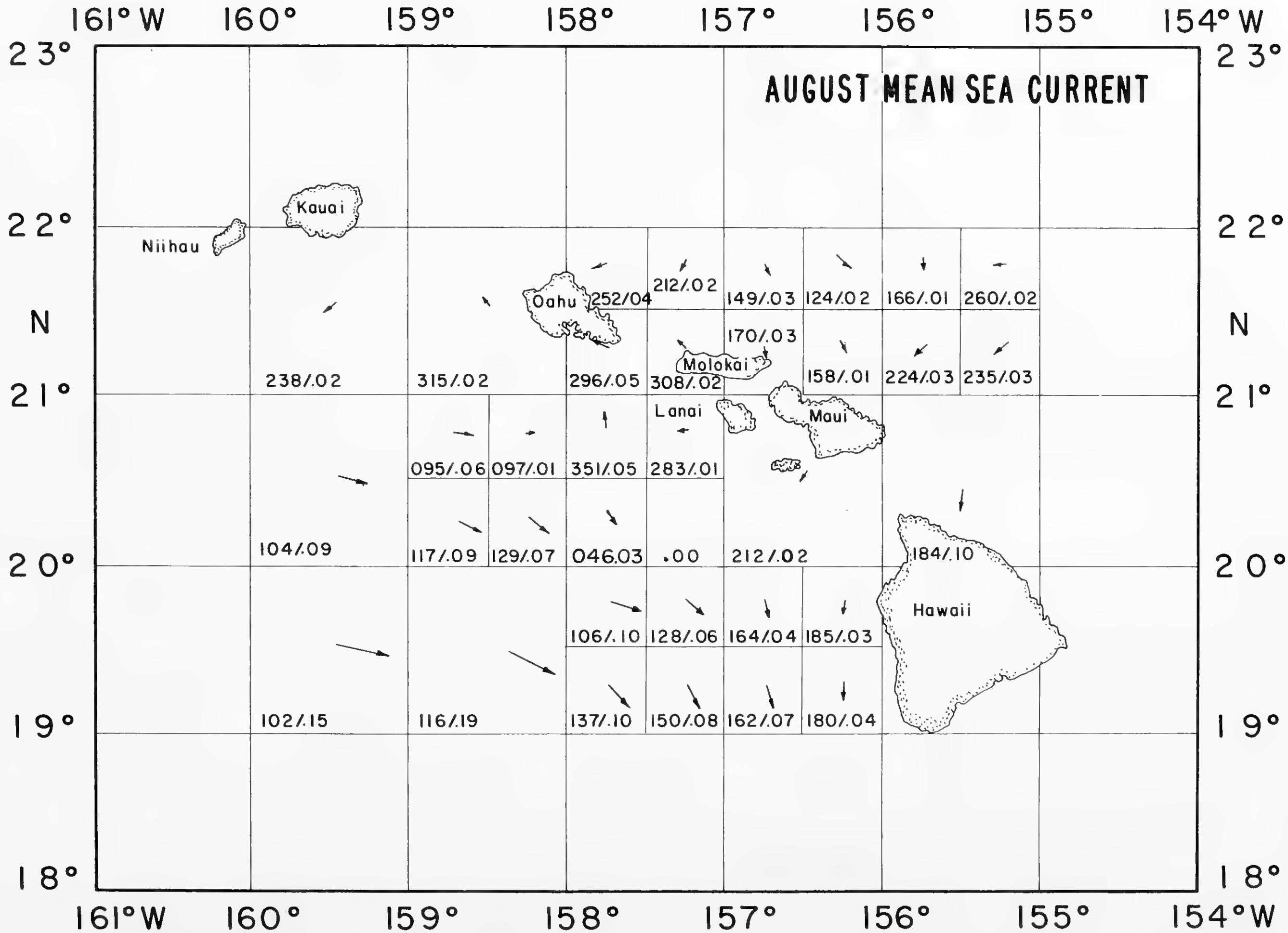

APRIL MEAN SEA CURRENT
161°W
160°
159°
158°
157°
156°
155°
154°W
23°
22°
N
21°
20°
19°
18°
Kauai
Niihau
Oahu
Molokai
Lanai
Maui
Hawaii
086/.05
088/.07
053/.02
057/.2
228/.01
219/.01
051/.02
061/.03
227/.02
284/.01
014/.05
078/.05
086/.04
101/.06
067/.05
047/.04
141/.04

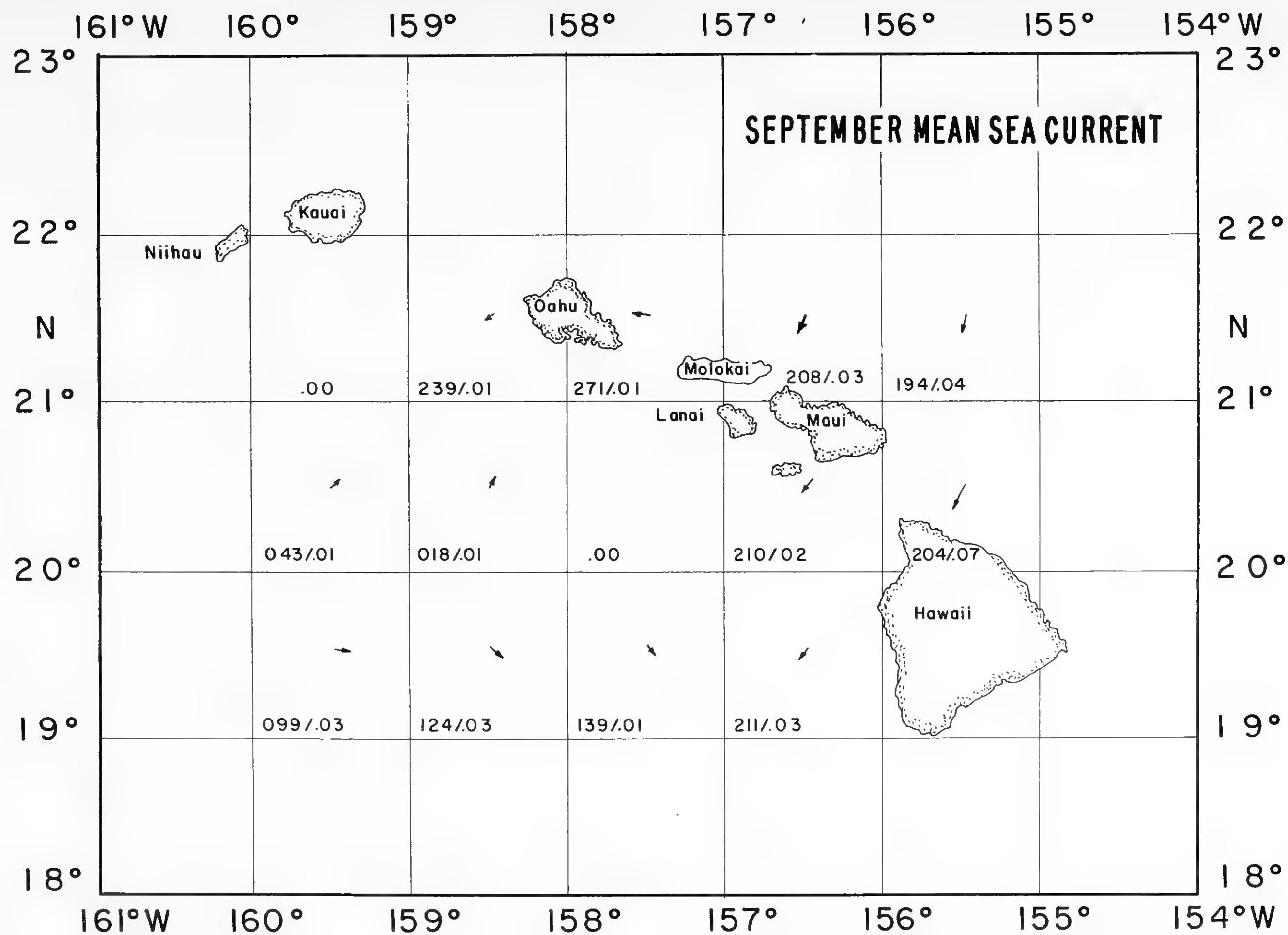

MAY MEAN SEA CURRENT
161°W
160°
159°
158°
157°
156°
155°
154°W
23°
22°
N
21°
20°
19°
18°
Kauai
Niihau
Oahu
Molokai
Lanai
Maui
Hawaii
026/.02
019/.02
325/.03
304/.03
212/.02
056/.08
094/.08
093/.03
006/.02
291/.01
054/.08
101/.04
105/.04
085/.08

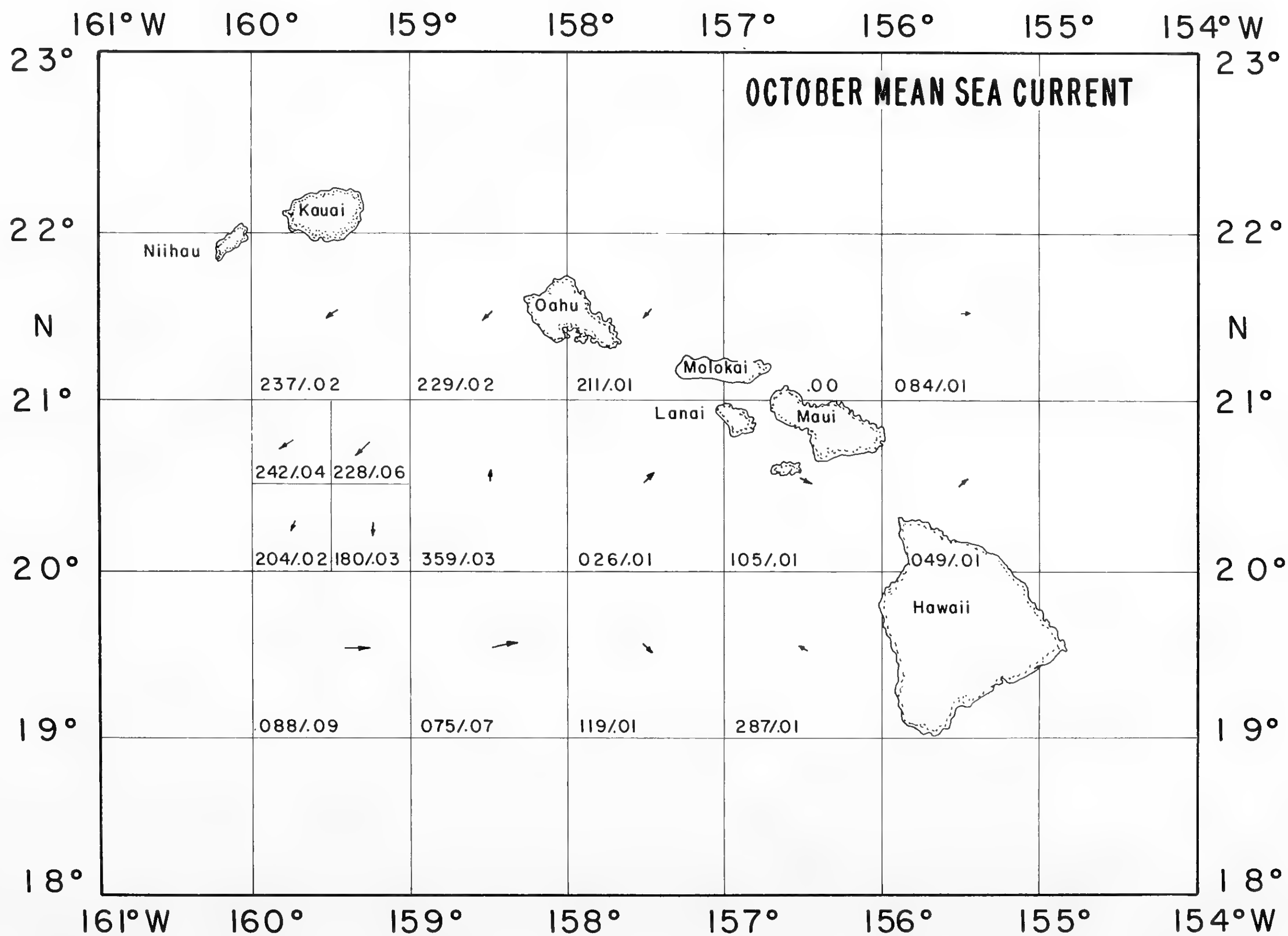

JUNE MEAN SEA CURRENT
161° W
160°
159°
158°
157°
156°
155°
154° W
23°
22°
N
21°
20°
19°
18°
Niihau
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
337/.02
352/.04
329/.03
316/.01
053/.01
011/.02
351/.03
359/.04
331/.05
332/.07
034/.02
027/.03
021/.03
013/.03
332/.01
255/.03
065/07
052/.04
060/.08
069/.03
070/.03
142/.04
100/.05

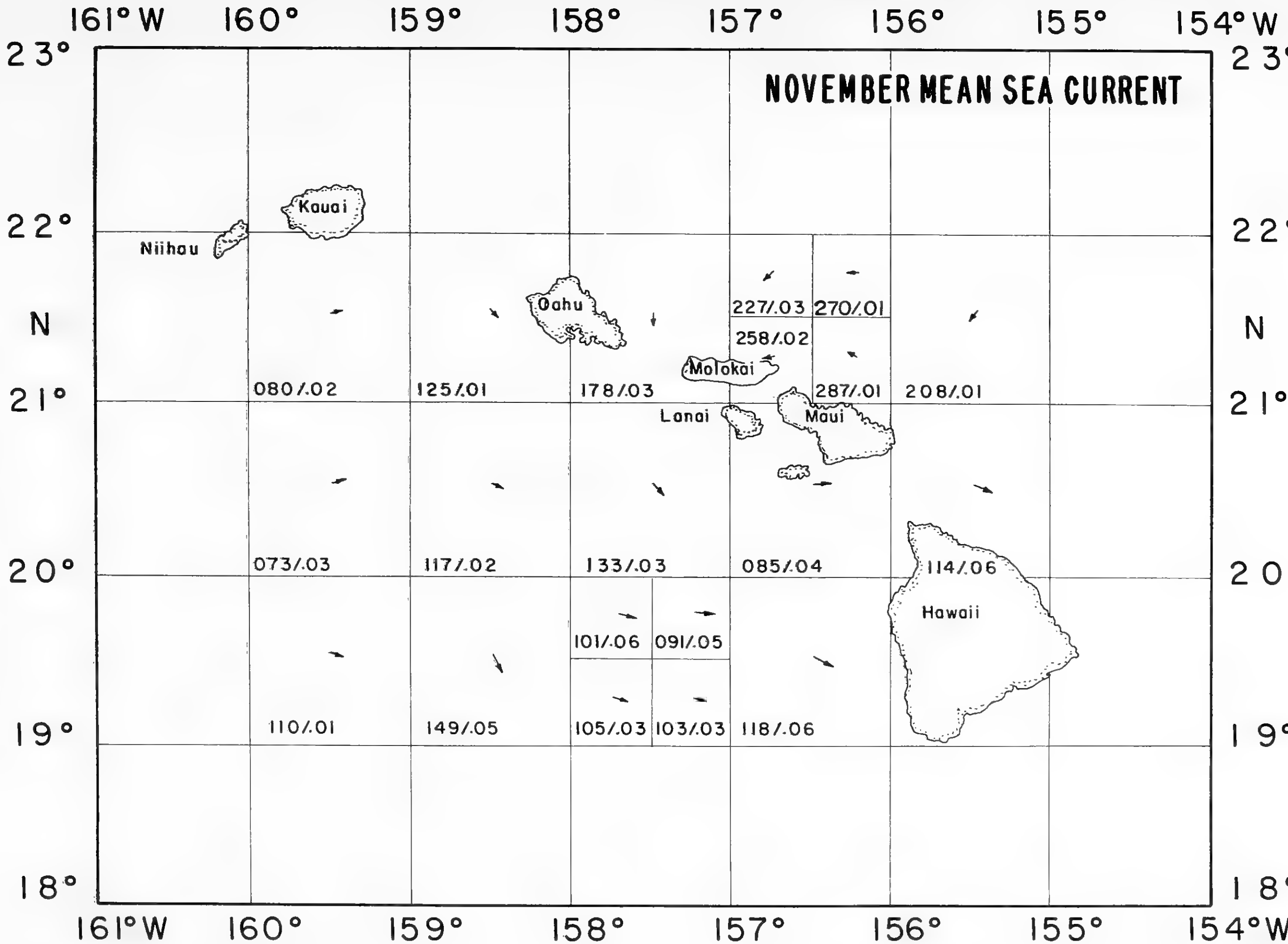


JULY MEAN SEA CURRENT
161° W
160°
159°
158°
157°
156°
155°
154° W
23°
22°
N
21°
20°
19°
18°
Kauai
Niihau
Oahu
Molokai
Lanai
Maui
Hawaii
308/.02
340/.04
327/.03
006/.03
355/.01
340/.05
289/.02
318/.03
346/.05
349/.02
340/.03
344/.04
299/.02
075/.02
032/.01
052/.07
029/.08
041/.04
107/.03
099/.02

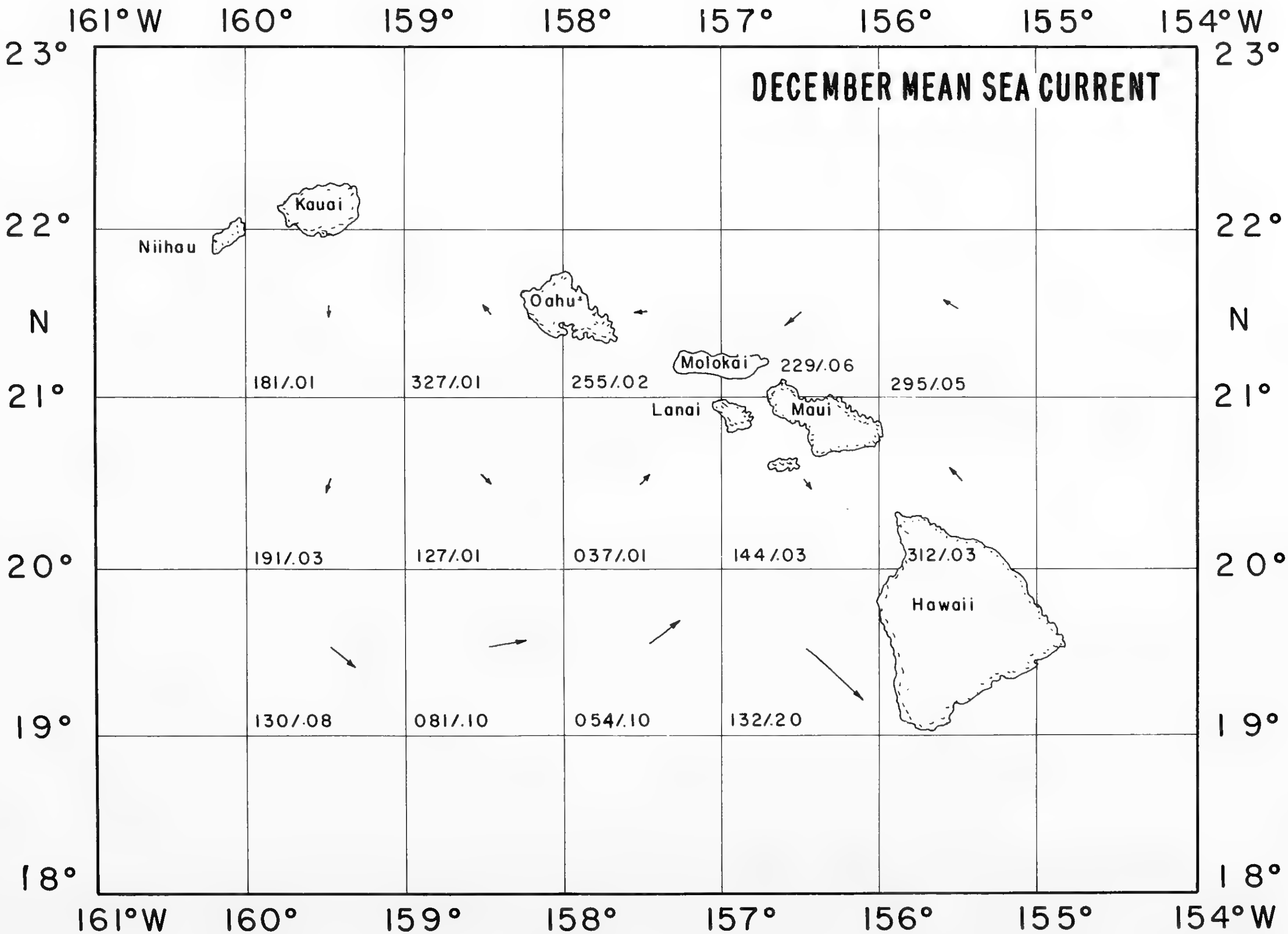

161° W
160°
159°
158°
157°
156°
155°
154° W
23°
22°
N
21°
20°
19°
18°
AUGUST MEAN SEA CURRENT
Kauai
Niihau
Oahu
Molokai
Lanai
Maui
Hawaii
252/04
212/.02
149/.03
124/.02
166/.01
260/.02
170/.03
238/.02
315/.02
296/.05
308/.02
158/.01
224/.03
235/.03
095/.06
097/.01
351/.05
283/.01
104/.09
117/.09
129/.07
046.03
.00
212/.02
184/.10
106/.10
128/.06
164/.04
185/.03
102/.15
116/.19
137/.10
150/.08
162/.07
180/.04


SEPTEMBER MEAN SEA CURRENT
161° W
160°
159°
158°
157°
156°
155°
154° W
23°
22°
N
21°
20°
19°
18°
Niihau
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
.00
239/.01
271/.01
208/.03
194/.04
043/.01
018/.01
.00
210/02
204/.07
099/.03
124/.03
139/.01
211/.03


OCTOBER MEAN SEA CURRENT
161° W
160°
159°
158°
157°
156°
155°
154° W
23°
22°
N
21°
20°
19°
18°
Kauai
Niihau
Oahu
Molokai
Lanai
Maui
Hawaii
237/.02
229/.02
211/.01
.00
084/.01
242/.04
228/.06
204/.02
180/.03
359/.03
026/.01
105/.01
049/.01
088/.09
075/.07
119/.01
287/.01



NOVEMBER MEAN SEA CURRENT
161° W
160°
159°
158°
157°
156°
155°
154° W
23°
22°
N
21°
20°
19°
18°
Niihau
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
227/.03
270/.01
258/.02
080/.02
125/.01
178/.03
287/.01
208/.01
073/.03
117/.02
133/.03
085/.04
114/.06
101/.06
091/.05
110/.01
149/.05
105/.03
103/.03
118/.06


DECEMBER MEAN SEA CURRENT
161° W
160°
159°
158°
157°
156°
155°
154° W
23°
22°
21°
20°
19°
18°
N
Niihau
Kauai
Oahu
Molokai
Lanai
Maui
Hawaii
181/.01
327/.01
255/.02
229/.06
295/.05
191/.03
127/.01
037/.01
144/.03
312/.03
130/.08
081/.10
054/.10
132/.20

GPO 887-325